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Radiological Health Data

VOLUME III, NUMBER 5

MAY 1962

MONTHLY REPORT

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Except where material is directly quoted or otherwise credited, summaries and abstracts are prepared by the Radiological Health Data and Reports Staff, Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
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RADIOLOGICAL HEALTH DATA

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

UNITS AND EQUIVALENTS

For the convenience of the reader, a selected list of units and equivalents frequently used in *Radiological Health Data* (*RHD*) are presented below.

Symbol	Name of unit	Equivalents
cpm	count per minute.	
dpm	disintegration per minute.	
$\mu\mu c$	micromicrocurie	1 $\mu\mu c$ = 2.22 dpm.
mc/km^2	millicurie per square kilometer	1 mc/km^2 = 1000 $\mu\mu c/m^2$ = 2.59 mc/mi^2.
mi^2	square mile.	
m^2	square meter.	
m^3	cubic meter	1 m^3 = 1000 liters.
gm	gram.	
kg	kilogram	1 kg = 1000 gm.
mm	millimeter	precipitation: $mm = \frac{\mu\mu c/m^2}{\mu\mu c/liter}$
mr/hr	milliroentgen per hour.	

SECTION I.—AIR

Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network (RSN) was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of radioactivity in air and precipitation due to fallout from nuclear weapons tests. Prior to September 1961, the Network consisted of 45 stations at urban locations operated by State and local health department personnel, except for 2 stations which were operated by Public Health Service personnel. Following the September 1961 resumption of nuclear weapons testing by the U.S.S.R., the Network was expanded over a period of a few months to 63 stations (see figure 1).

Air

Measurements of gross beta radioactivity in air at ground level are taken because they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological effects is not possible from these data alone.

Daily air samples are collected continuously by a high volume air sampler with a carbon-loaded cellulose dust filter. Field measurements with a portable survey meter enable the operator to estimate the amount of beta activity of particulates in air at the station five hours after collection by comparison with a known radioactive source. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network for a more refined measurement using a thin-window gas flow proportional counter. The fission-product gross beta average concentrations in surface air during February 1962 are tabulated in table 1. The data shown represent the activities extrapolated to the time of collection.

Precipitation

Continuous sampling for total precipitation is conducted at each station on a daily basis using locally-made funnels having collection areas of 0.4 square meter (m^2). One-half liter of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples.

The monthly averages of gross beta activity in precipitation, expressed in micromicrocuries per liter ($\mu\mu c$/liter) and micromicrocuries per square meter ($\mu\mu c/m^2$), are presented in table 2 for February 1962. The total precipitation for the month, expressed in millimeters (mm), may be computed directly from the data by

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

using the following expression:

$$\text{Total precipitation (mm)} = \frac{\text{Total activity } (\mu\mu c/m^2)}{\text{Average concentration } (\mu\mu c/\text{liter})}$$

When the gross beta concentration of a given daily precipitation sample is too low for reliable measurement, an activity ($\mu\mu c/m^2$) calculated from the minimum level of detection is included in the monthly summation of activity. In the event that the sum of such "less-than" activities is greater than one-tenth of the total gross beta activity for the month, the monthly activity is reported with a less-than (<) sign.

Review: Concentration of Fission Products

Because of U.S.S.R. nuclear weapons testing during September, October, and November 1961, the four-month span from September through December provides some interesting observations.

Each of the seventeen maps in figure 2 shows the geographic distribution of the approximate concentrations of gross beta in air averaged over a seven-day period. Only one week showed concentrations exceeding 50 $\mu\mu c/m^3$. For further details, refer to the daily iso-concentration maps for September 16-27 in November 1961 *RHD*.

TABLE 1.—GROSS BETA ACTIVITY OF PARTICULATES IN AIR, RSN, FEBURARY 1962

[Concentrations in $\mu\mu c/m^3$]

City	State	Number samples	Maximum	Minimum	Average [1]	City	State	Number samples	Maximum	Minimum	Average [1]
Adak	Alaska	16	5.3	0.30	2.3	Lansing	Mich	28	17	3.6	8.1
Anchorage	Alaska	19	14	1.1	5.1	Minneapolis	Minn	17	4.3	1.8	3.7
Attu	Alaska	19	7.0	0.20	2.3	Jackson	Miss	18	11	1.2	6.1
Cold Bay	Alaska	17	3.5	<0.10	1.3	Pascagoula	Miss	19	14	2.9	7.9
Fairbanks	Alaska	20	11	1.7	5.7	Jefferson City	Mo	18	8.8	1.2	4.8
Juneau	Alaska	19	19	3.0	9.0	Helena	Mont	16	9.8	1.6	5.1
Kodiak	Alaska	19	5.2	0.40	2.5	Lincoln	Nebr	—	—	—	—
Nome	Alaska	[b]—	—	—	—	Trenton	N. J	17	11	0.27	4.6
Point Barrow	Alaska	11	5.4	1.8	3.4	Santa Fe	N. Mex	19	14	2.6	8.0
St. Paul Island	Alaska	21	4.1	<0.10	2.0	Albany	N. Y	18	8.6	0.87	5.6
Phoenix	Ariz	9	13	1.9	5.8	New York	N. Y	4	21	7.2	11
Little Rock	Ark	18	10	1.9	5.4	Gastonia	N. C	20	14	1.9	7.2
Berkeley	Calif	18	10	1.4	5.1	Bismarck	N. D	18	6.1	1.4	3.7
Los Angeles	Calif	18	12	0.28	7.1	Columbus	Ohio	18	16	2.6	8.0
Denver	Colo	18	12	2.9	5.7	Oklahoma City	Okla	18	13	3.0	6.4
Hartford	Conn	16	8.1	0.81	5.3	Ponca City	Okla	20	6.0	1.0	2.7
Washington	D. C	27	13	0.60	6.1	Portland	Oreg	19	18	1.9	7.3
Jacksonville	Fla	18	12	2.5	9.4	Harrisburg	Pa	15	19	<0.10	9.2
Miami	Fla	20	16	2.5	6.3	San Juan	P. R	7	8.0	1.8	4.8
Atlanta	Ga	17	12	1.9	6.0	Providence	R. I	18	10	2.5	6.3
Agana	Guam	24	14	0.60	6.0	Columbia	S. C	19	9.2	1.3	5.3
Honolulu	Hawaii	19	9.6	0.50	4.4	Pierre	S. D	8	7.9	2.5	5.2
Boise	Idaho	19	10	2.0	5.8	Nashville	Tenn	15	11	0.38	6.8
Springfield	Ill	19	8.5	1.0	4.4	Austin	Tex	16	20	0.97	8.6
Indianapolis	Ind	18	13	1.2	4.8	El Paso	Tex	19	13	2.8	8.5
Iowa City	Iowa	20	6.0	1.9	4.3	Salt Lake City	Utah	19	9.0	1.8	8.1
Topeka	Kans	19	9.5	1.5	5.1	Richmond	Va	18	7.5	1.0	4.5
Frankfort	Ky	18	18	0.88	7.1	Seattle	Wash	18	16	0.40	4.3
New Orleans	La	19	12	2.5	6.0	Madison	Wis	20	12	1.5	5.6
Augusta	Maine	28	9.1	3.2	5.7	Cheyenne	Wyo	20	11	2.2	5.3
Baltimore	Md	19	11	0.25	5.9	Sundance	Wyo	5	7.9	3.3	5.6
Lawrence	Mass	19	8.2	1.9	5.1	Network average					5.72

[1] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, FEBRUARY 1962

Station location		Average concentration ($\mu\mu c$/liter)	Total activity ($\mu\mu c/m^2$)	Station location		Average concentration ($\mu\mu c$/liter)	Total activity ($\mu\mu c/m^2$)
City	State			City	State		
Adak	Alaska	[a]—	—	Lansing	Mich	1,180	49,500
Anchorage	Alaska	730	7,700	Minneapolis	Minn	1,500	30,400
Attu	Alaska	—	—	Jackson	Miss	580	32,800
Cold Bay	Alaska	—	—	Pascagoula	Miss	3,300	36,000
Fairbanks	Alaska	1,500	41,700	Jefferson City	Mo	3,000	139,000
Juneau	Alaska	1,600	55,100	Helena	Mont	3,800	43,200
Kodiak	Alaska	—	—	Lincoln	Nebr	4,200	59,000
Nome	Alaska	—	—	Trenton	N. J	—	—
Point Barrow	Alaska	—	—	Santa Fe	N. Mex	14,000	17,000
St. Paul Island	Alaska	—	—	Albany	N. Y	700	42,670
Phoenix	Ariz	—	—	New York	N. Y	—	—
Little Rock	Ark	1,100	219,000	Gastonia	N. C	930	87,090
Berkeley	Calif	650	134,000	Bismarck	N. D	880	11,100
Los Angeles	Calif	890	305,000	Columbus	Ohio	2,267	119,500
Denver	Colo	470	4,500	Oklahoma City	Okla	1,200	38,500
Hartford	Conn	2,200	130,900	Ponca City	Okla	2,200	28,600
Washington	D. C	1,600	136,300	Portland	Oreg	1,400	58,800
Jacksonville	Fla	1,500	18,800	Harrisburg	Pa	1,600	35,650
Atlanta	Ga	950	135,800	San Juan	P. R	—	—
Agana	Guam	—	—	Providence	R. I	3,000	331,000
Honolulu	Hawaii	1,200	82,000	Columbia	S. C	2,600	72,500
Boise	Idaho	900	13,400	Pierre	S. Dak	760	34,900
Springfield	Ill	3,100	20,000	Nashville	Tenn	1,000	208,700
Indianapolis	Ind	2,100	90,100	Austin	Tex	2,500	44,000
Iowa City	Iowa	2,900	173,700	El Paso	Tex	1,000	15,000
Topeka	Kans	5,200	56,000	Salt Lake City	Utah	2,800	110,900
Frankfort	Ky	1,100	66,200	Richmond	Va	1,900	152,600
New Orleans	La	1,200	84,700	Seattle	Wash	1,600	31,200
Augusta	Maine	1,200	42,100	Madison	Wis	1,790	60,800
Baltimore	Md	—	—	Cheyenne	Wyo	1,000	10,300
Lawrence	Mass	1,300	50,700	Sundance	Wyo	—	—

[a] Dash denotes no sample received.

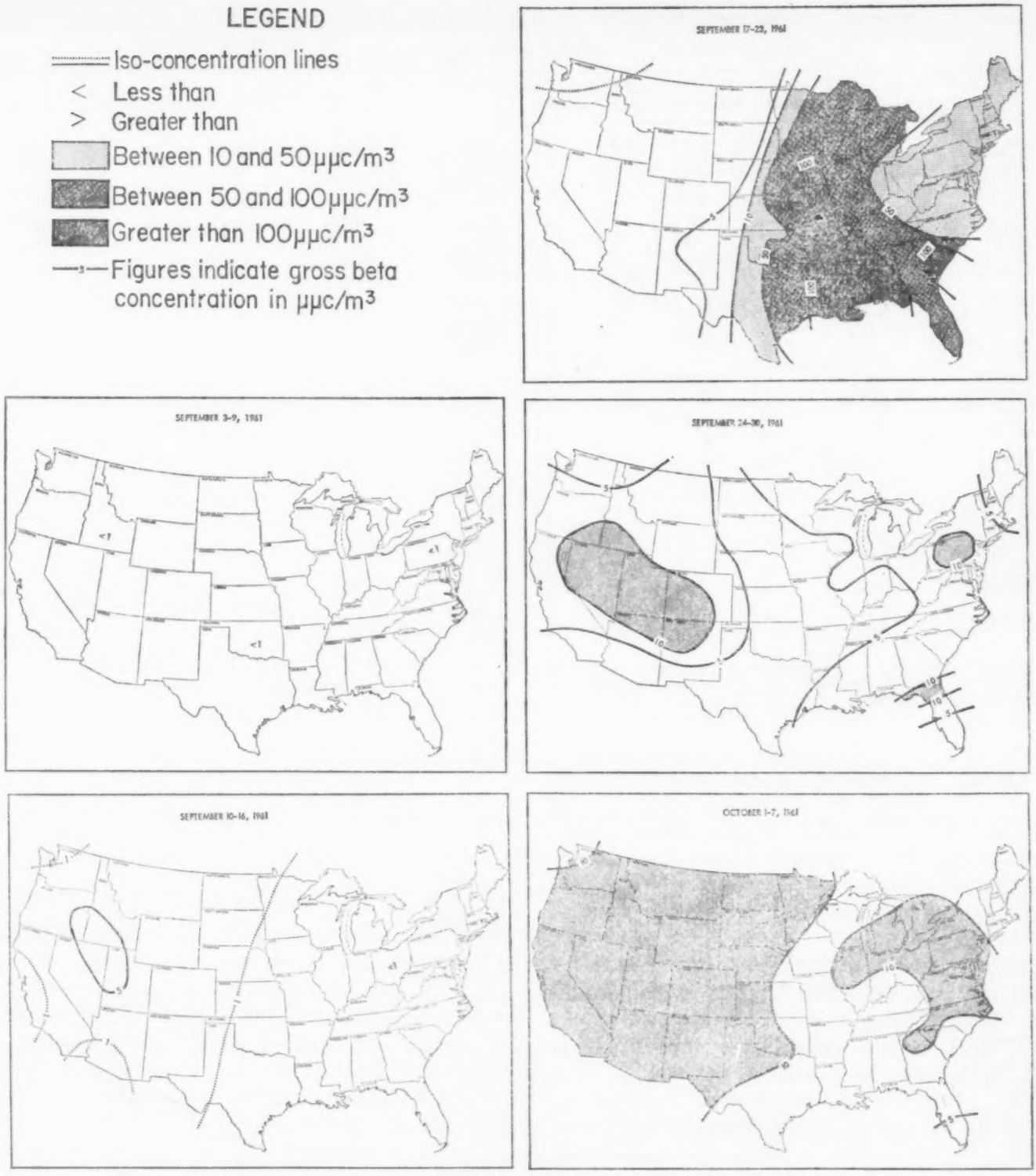

FIGURE 2.—WEEKLY AVERAGE GROSS BETA CONCENTRATIONS IN AIR, RADIATION SURVEILLANCE NETWORK, SEPTEMBER 3–DECEMBER 30, 1961

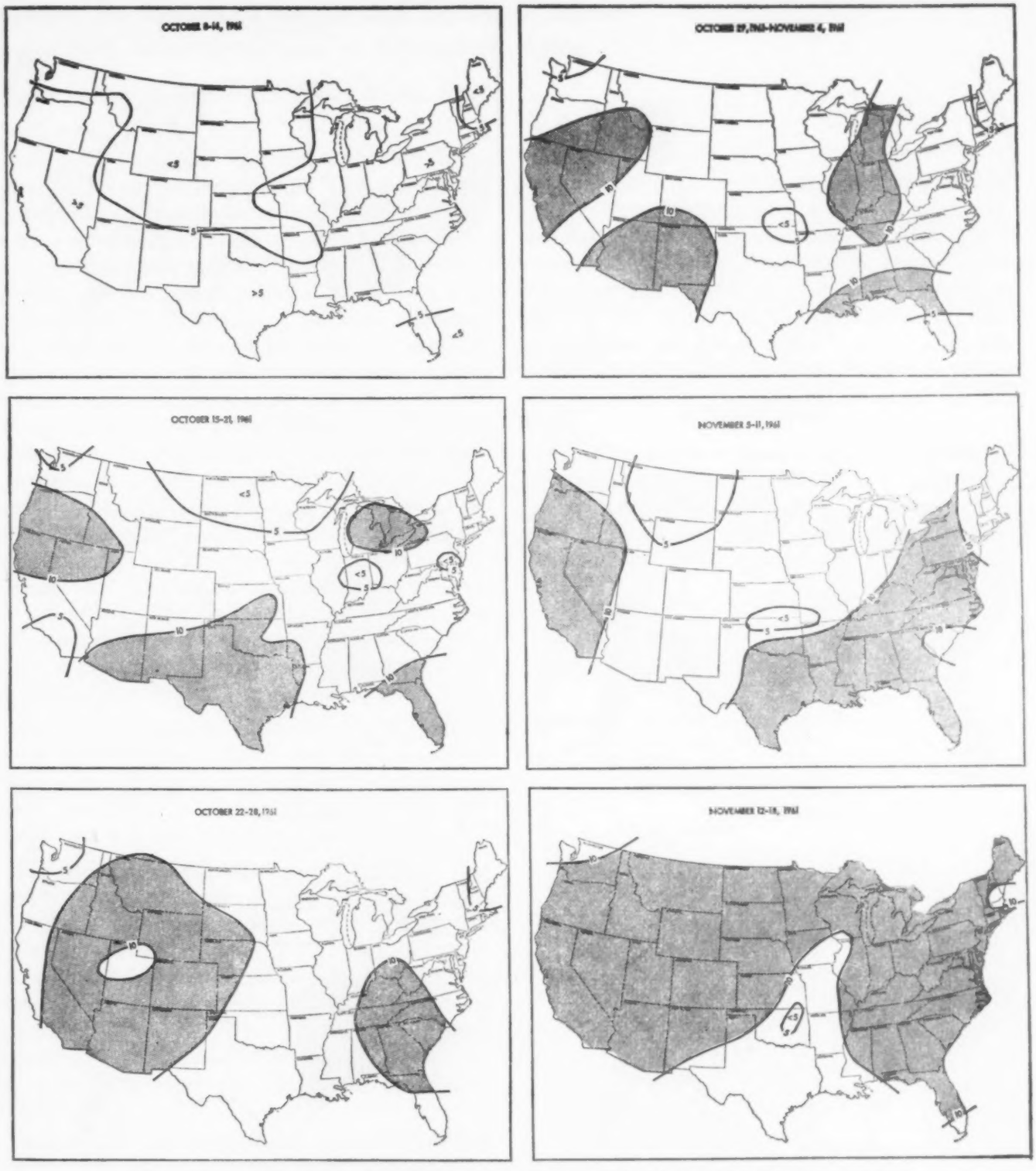

FIGURE 2.—WEEKLY AVERAGE GROSS BETA CONCENTRATIONS IN AIR, RADIATION SURVEILLANCE NETWORK, SEPTEMBER 3–DECEMBER 30, 1961—CONTINUED

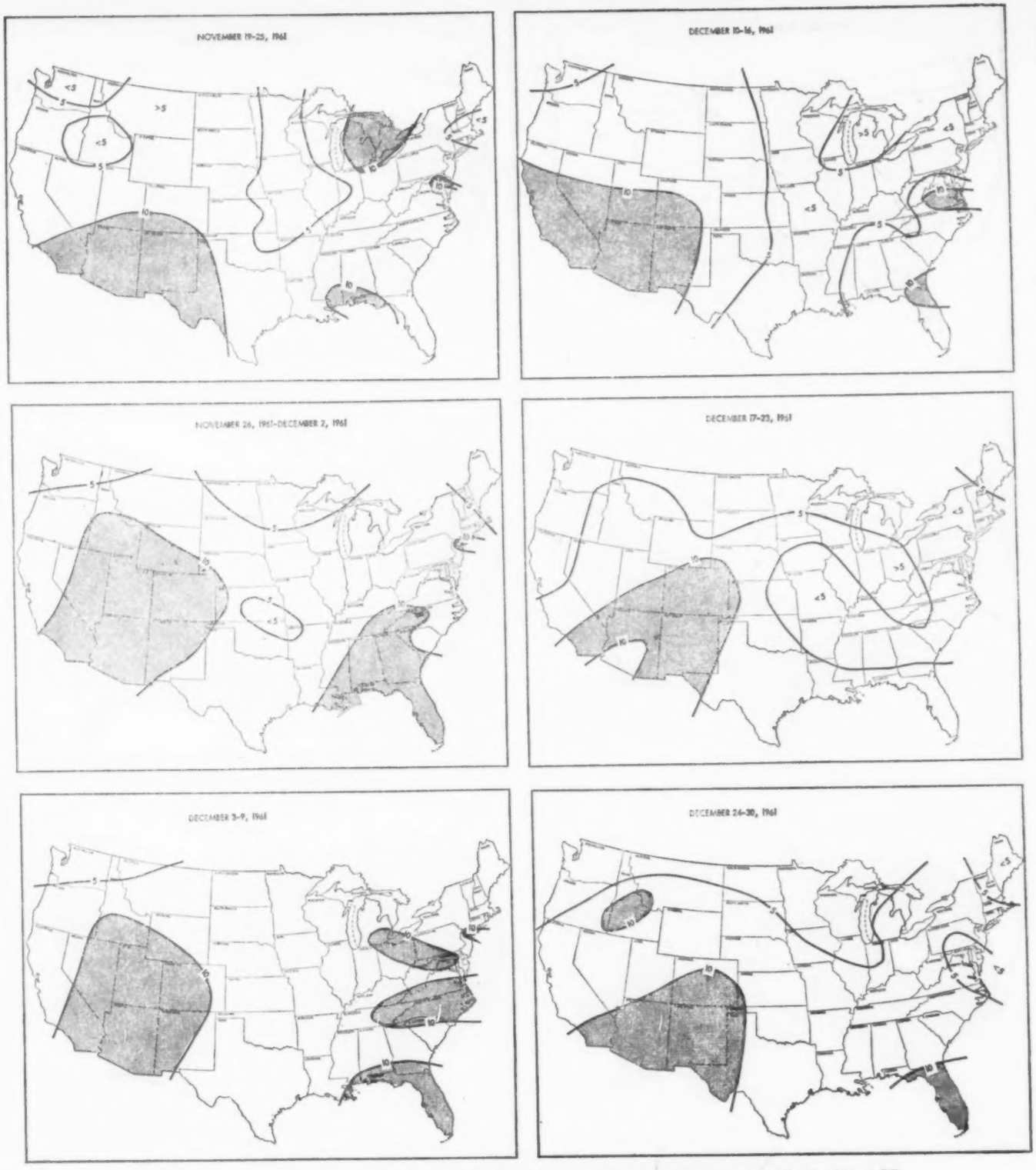

FIGURE 2.—WEEKLY AVERAGE GROSS BETA CONCENTRATIONS IN AIR, RADIATION SURVEILLANCE NETWORK, SEPTEMBER 3–DECEMBER 30, 1961—CONTINUED

Surface Air Radon, Thoron, and Fission Product Gross Beta Concentrations at Cincinnati, Ohio

Division of Radiological Health, Public Health Service

The determination of natural background radiation in our atmosphere is useful because the exposure levels from natural radiation can be used as a base for comparative evaluations of exposures from artificially produced radionuclides. Natural radioactivity in surface air is attributed to a number of unstable nuclides other than those produced by man. The earth's crust contains trace amounts of uranium and thorium that occur naturally and which decay through a series of their daughter products. These decay products of uranium and thorium are introduced into surface air through their rare gas daughters, radon (radon-222) and thoron (radon-220), which in turn continue to decay through the uranium and thorium series, respectively. The radon and thoron content of air depends on the escape of these rare radioactive gases from the earth. Concentrations depend on prevailing atmospheric conditions such as moisture, porosity, and temperature.

Most of the natural radioactivity in surface air is due to radon (Rn^{222}) and its daughters. Thoron (Rn^{220}) and its daughters contribute much less because of thoron's short half-life and hence, a lower diffusion rate from the soil.

Radiological Health Research Activities, Research Branch, Division of Radiological Health, Public Health Service, performs a continuous daily sampling program for radon (Rn^{222}), thoron (Rn^{220}), and gross beta fission product concentrations in surface air. The gross beta activity of atmospheric particulates, when measured several days after sample collection, is principally due to artificially produced radionuclides.

Radon-222 concentrations are determined from alpha measurements made immediately after the sampling period (24 to 72 hours) has ceased. Radon-222 (a.m.) concentrations have been corrected for any radon-220 daughter interferences. Radon-222 (p.m.) concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. These values are from the same filters that are counted at 8 a.m. the following day. Radon-222 (p.m.) concentrations are uncorrected for any radon-220 daughter interferences. Radon-220 concentrations are determined from alpha measurements made on the sample used to evaluate the corrected radon-222 (a.m.) concentrations, but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter.

The data are now computed by an electronic data processing system which is programmed for thirteen four-week periods per calendar year. The data for the period January 29–February 23, 1962, appears in table 1.

REFERENCE

Setter, L. R. and G. I. Coats "The Determination of Airborne Radioactivity," *American Industrial Hygiene Association Journal, 22*, No. 1, Feb. 1961.

TABLE 1.—SURFACE AIR RADON (Rn^{222}), THORON (Rn^{220}), AND FISSION PRODUCT GROSS BETA CONCENTRATIONS AT CINCINNATI, OHIO, JANUARY 29–FEBRUARY 23, 1962

End of sampling period	Sample collection		Rn^{222} 8 a.m. ($\mu\mu c/m^3$)	Rn^{222} 3 p.m.[a] ($\mu\mu c/m^3$)	Rn^{220} ($\mu\mu c/m^3$)	Beta activity ($\mu\mu c/m^3$)
	Sample period (hours)	Volume (m^3)				
January 29	71.8	88.4	120	160	1.1	9.54
30	24.0	29.9	170	120	0.8	10.45
31	23.9	29.7	160	30	1.2	5.32
February 1	24.4	30.1	200	90	1.1	9.15
2	23.6	29.1	130	100	0.5	8.03
5	71.9	87.0	280	80	1.8	10.08
6	23.9	29.9	80	80	0.5	5.37
7	23.9	30.0	190	100	1.0	5.48
8	23.9	29.9	180	150	1.2	9.94
9	23.9	29.8	190	140	1.4	22.40
12	71.9	86.5	320	130	1.4	11.40
13	23.9	29.4	220	190	0.5	13.79
14	23.9	29.3	130	130	0.7	9.05
15	23.9	29.5	100	90	0.5	2.63
16	23.9	29.7	120	130	0.9	9.16
19	71.9	87.2	180	120	1.4	3.27
20	23.9	29.8	50	30	0.5	3.65
21	23.9	30.0	100	120	1.4	12.64
23	47.9	59.4	110	120	0.9	7.54
Average			176	114	1.1	8.75
Range of counting errors (2σ)						
Maximum			32	24	0.5	0.28
Minimum			12	10	0.2	0.06

[a] Sample period and volume does not apply to this column.

Radioactivity Measurements in Surface Air Near The 80th Meridian (West)

U. S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites near the 80th Meridian (West) have been made since 1956. Sampling locations are shown in figure 1. This program is operated by the U. S. Naval Research Laboratory (NRL) with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which have made the actual sample collections and forwarded them to NRL for analysis. Partial financial support of this program is provided by the Division of Biology and Medicine, U. S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously at a rate of approximately 1200 cubic meters per day through high efficiency filters, 8-inches in diameter, using positive displacement blowers. Due to the decrease of radioactivity levels during 1960 and 1961, it became necessary to change the sampling period from a daily to a weekly basis at most stations. After the sample is removed, it is forwarded immediately to NRL for assay of gross beta activity two weeks after collection.

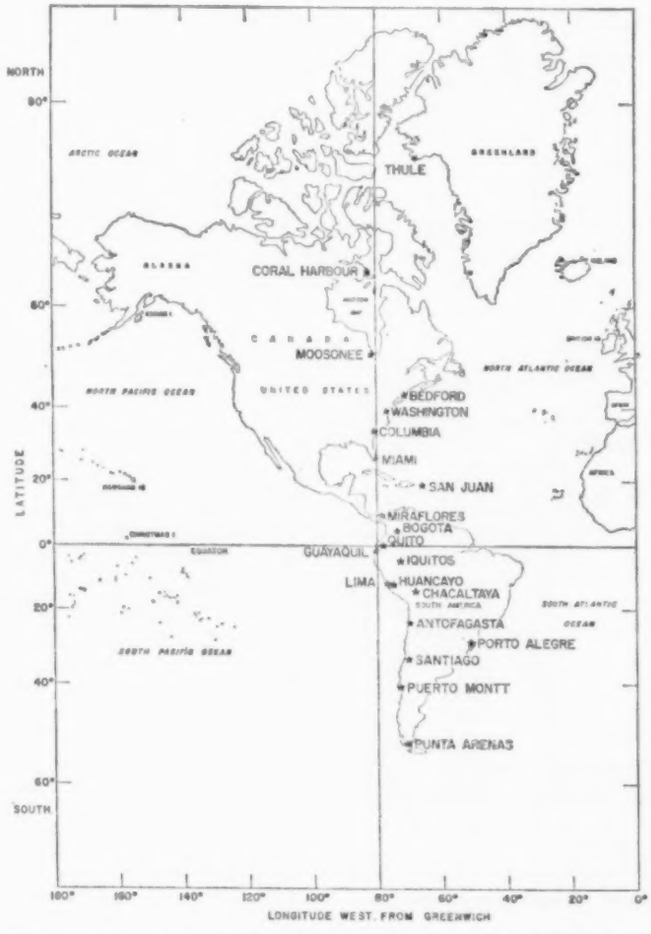

FIGURE 1.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN WEST

Fission product beta concentrations during January 1962 are reported in table 1 somewhat differently than were earlier data from this program. Each sample is represented by a rectangle whose boundaries indicate station, length of sampling period, and dates of sampling. The average gross beta concentration in micromicrocuries per cubic meter (formerly reported as disintegrations per minute per cubic meter) for each sampling period appears within the appropriate rectangle. Beginning with the January data, the gross beta concentrations reflect recent recalibration of the equipment.

Radiochemical analyses are performed on monthly composite air-filter samples for the following nuclides: strontium-89, strontium-90, yttrium-91, cesium-137, cerium-141, cerium-144, promethium 147, tungsten-185, and lead-210. The 1960 analyses were reported in the March 1962 *Radiological Health Data*. The 1961 analyses will be reported in a future issue.

The gross β measurements indicate that radioactive debris from the 1961 Soviet nuclear test series appeared at Guayaquil, Ecuador during January 1962; these measurements are not sufficiently specific, however, to prove the presence of Soviet debris at other Southern Hemisphere sites. Radiochemical analyses which are highly specific for the short-lived fission products produced in the USSR explosions have just been completed for the isotope Ce^{141} in some of the air filter samples collected along the 80th meridian during November and December 1961. Small but identifiable quantities of Ce^{141} (33 day half-life) have been found as far south as Santiago, Chile in a concentration range in the order of 1–2%

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NRL, JANUARY 1962[a]

[Average concentrations in $\mu\mu c$/liter]

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Can. Z.	San Juan, P. R.	Mauna Loa,[b] Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland
1	0.018	0.034	0.050	0.112	0.035	0.090	0.168	1.30	1.72	4.39	11.25	3.89	3.38	
2													2.82	
3													4.73	
4														
5	0.004	0.027	0.069	—[c]	0.010	0.007	0.112	1.65	4.97	1.95	7.56	7.02	2.27	—
6													2.95	
7													4.47	
8													7.46	
9													4.31	4.54
10													3.84	
11													6.00	
12	0.014	0.024	0.065	0.139	0.031	0.049	0.276	6.25	6.20	5.50	9.32	6.39	7.82	5.31
13													5.49	
14													5.64	
15													4.32	
16														
17														
18														
19	0.055	0.023	0.063	0.059	0.061	0.026	0.523	4.36	5.02	2.99	8.73	6.84	3.65	6.57
20														
21														
22														
23														
24														
25														
26	0.027	0.067	—	0.084	0.026	0.065	0.394	3.26	4.71	3.09	6.21	8.37	3.24	
27														3.16
28														
29	—													
30														
31	0.024	—	0.103	0.079	0.026	0.038	0.828	2.59	3.88	1.30	8.01	5.54	2.74	
														4.49
Mean	0.025	0.035	0.068	0.093	0.032	0.041	0.354	3.70	5.02	3.28	8.06	6.93	3.92	4.97

[a] Average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample averages according to the number of days in the sampling period or that portion of the sampling period occurring in January 1962.

[b] Mauna Loa data has been included for comparison with Chacaltaya, Bolivia. Both are high elevation stations (3400 and 5200 meters) and about equally-distant north and south of the equator.

[c] Dash indicates sample was not received because of motor, filter, or other mechanical failure.

of that found in the Northern Hemisphere. This isotope has not been detected in the Southern Hemisphere since the Spring of 1960, following the detonation of the first French nuclear device in the Sahara Desert. It is reasonable to assume that the same interhemispheric mixing processes that brought debris from the French test into the Southern Hemisphere can transport across the equator a portion of the debris from the Soviet tests that other processes have carried to the lower latitudes of the Northern Hemisphere.

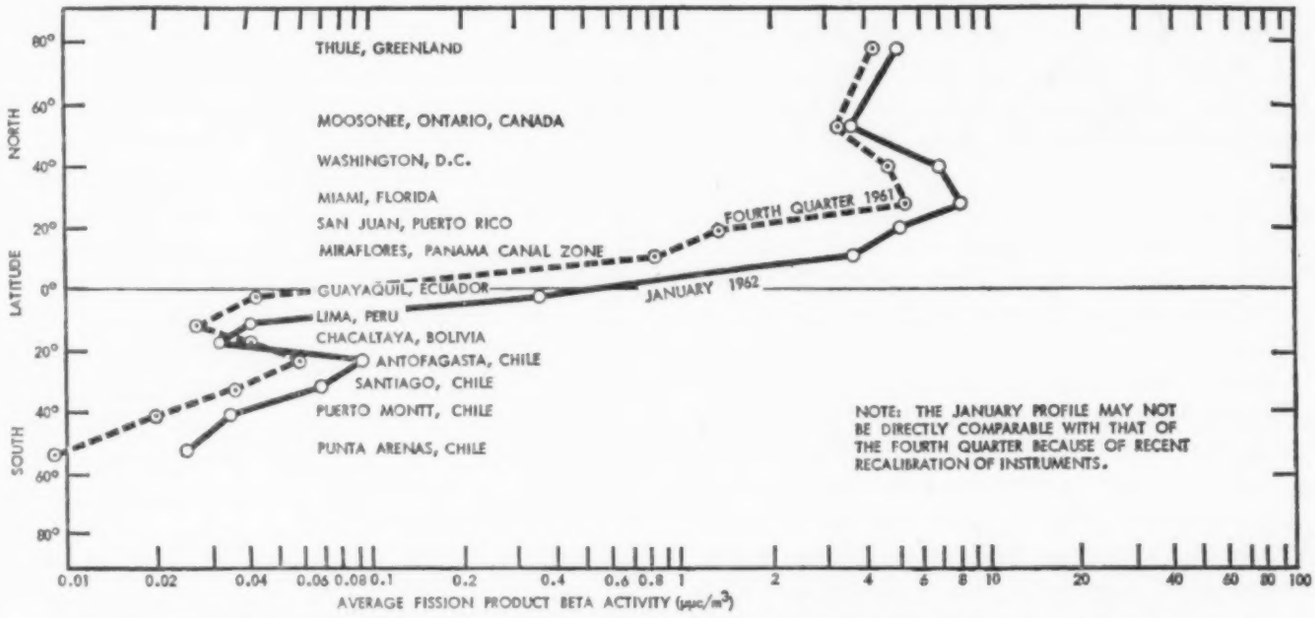

FIGURE 2.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN WEST, FOURTH QUARTER 1961

Canadian Radioactive Fallout Monitoring Program

Department of National Health and Welfare, Dominion of Canada

Third quarter 1961

As part of its Radioactive Fallout Monitoring Program (RFMP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, samples air, precipitation, and dried milk products. The discussion and results of the milk sampling program appear in Section II.

The nationwide air sampling program is conducted for two main purposes: (1) To provide a convenient method for the early detection of changes in the fission product concentration in the air and therefore of likely changes in the deposition of fission products on the ground, and (2) To obtain data to show the day-to-day and station-to-station variations in fission product concentrations as this may be useful to meteorologists in obtaining a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "An-

nual Report for 1959," Report Number CNHW (RP-3).

FIGURE 1.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

Previous coverage in *Radiological Health Data*

Period	*Issue*
July 1959–June 1960	January 1961
Third qaurter 1960	April 1961
Fourth quarter 1960	August 1961
First quarter 1961	December 1961
Second quarter 1961	February 1962

Tables 1 and 2 show the higher fission product levels in air and precipitation during September as a result of the U.S.S.R. nuclear weapons testing during that month. Note that the precipitation data are now given in micromicrocuries per liter (μμc/liter) and micromicrocuries per square meter (μμc/m²). [*To convert to other units such as millimeters of precipitation or millicuries per square mile (mc/mi²), see table of Units and Equivalents on page ii.*]

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, RFMP, THIRD QUARTER 1961

[Average concentrations in μμc/m³]

Station location	July	August	September	Station location	July	August	September
Calgary	0.16	0.08	5.9	Resolute	0.06	0.02	1.7
Chatham	0.13	0.06	20.2	Saskatoon	0.14	0.05	14.1
Coral Harbour	0.10	0.08	3.2	Shearwater	0.12	0.04	21.7
Edmonton	0.17	0.07	10.0	Torbay	0.10	0.07	13.5
Ft. Churchill	0.10	0.04	3.2	Toronto	0.15	0.07	36.3
Ft. William	0.14	0.06	41.1	Vancouver	0.09	0.05	4.4
Fredericton	0.12	0.04	17.4	Whitehorse	0.10	0.05	3.9
Goose Bay	0.10	0.06	9.2	Windsor	0.16	0.09	27.8
Inuvik	0.11	0.04	8.9	Winnepeg	0.18	0.09	12.0
Kapuskasing	0.17	0.07	47.7	Yellowknife	0.17	0.07	14.5
Montreal	0.14	0.07	26.8				
Moosonee	0.09	0.06	36.8	Maximum Station Average	0.17	0.09	47.7
Ottawa	0.12	0.08	32.6	Minimum station average	0.06	0.02	1.7
Regina	0.17	0.08	11.3	Overall average	0.13	0.06	17.7

TABLE 2.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFMP, THIRD QUARTER 196

Station location	July		August		September	
	Concentration (μμc/liter)	Deposition (μμc/m²)	Concentration (μμc/liter)	Deposition (μμc/m²)	Concentration (μμc/liter)	Deposition (μμc/m²)
Calgary	25.8	3,900	40.0	1,100	2,070	70,000
Chatham	56.3	1,800	16.7	1,200	511	29,400
Coral Harbour	71.4	1,100	16.7	700	73	5,200
Edmonton	31.9	3,000	491	2,700	4,030	104,000
Fredericton	31.9	2,000	18.2	1,600	304	23,200
Ft. Churchill	80.5	3,200	63.8	2,100	9,950	594,000
Ft. William	25.9	3,100	56.2	2,400	1,390	216,000
Goose Bay	10.7	1,900	22.8	1,500	541	44,800
Inuvik	35.0	1,200	30.4	1,500	9,870	74,900
Kapuskasing	22.8	3,300	19.8	2,200	2,700	399,000
Montreal	10.6	700	3.0	500	—	—
Moosonee	[a] —	—	41.0	3,000	2,800	201,000
Ottawa	38.0	2,100	28.9	2,800	821	37,600
Regina	68.4	1,700	629	1,100	1,750	22,700
Resolute	53.2	2,500	—	—	—	—
Saskatoon	24.4	1,600	1,670	1,700	2,470	52,100
Shearwater	33.4	1,700	—	—	681	42,200
Torbay	27.4	1,100	16.7	600	564	28,800
Toronto	38.0	3,000	73.0	2,900	664	28,300
Vancouver	22.8	900	33.4	1,400	5,110	241,000
Whitehorse	53.2	1,300	24.3	800	856	27,200
Windsor	19.8	1,400	24.3	3,900	278	32,000
Winnipeg	31.9	2,700	465	1,900	616	36,000
Yellowknife	35.0	2,000	18.3	350	1,680	61,000
Average	36.9	2,050	173	1,740	2,260	108,500

[a] Dash denotes no sample.

SECTION II.—MILK

Milk Monitoring Program

Division of Radiological Health
Division of Environmental Engineering and Food Protection,
Public Health Service

Milk monitoring has been conducted by the Public Health Service since early 1957, when the first program was established to develop suitable sampling methods and radiochemical analytical proficiencies. Raw milk was initially selected for investigation. During this program, it became evident that a broader sampling program was necessary—one more directly related to the milk consumed by the population. The result was the initiation, in the first quarter of 1960, of a pasteurized milk sampling program designed to provide data representative of the milk consumed in selected municipalities. Both programs were operated concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those of the new program.

Raw milk sampling results reported for June 1961 in the November 1961 *RHD* were the last regular publication of such data. A summary discussion of the raw milk sampling program in the December 1961 *RHD* presented the gross relationship between fallout and the occurrence of fission products in milk determined from this study.

During December 1961, the surveillance of pasteurized milk was conducted at 61 stations (shown in figure 1) with the cooperation of State and local milk sanitation agencies who shipped samples to the PHS Southeastern and Southwestern Radiological Health Laboratories for analysis. The former analyzes samples from the 30 states generally east of the Mississippi River, and the latter analyzes samples from the western states. Publication in *RHD* follows about four months after sample collection because of time required for shipment, processing, decay-product buildup, data compilation, and publication procedures.

The current program emphasizes (1) measurement of the levels of radioactivity of samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within virtually all states and additional points when indicated by widely varying conditions of the milk supply or the need to cover large population groups. Each sample is composited in proportion to the volume of milk sold by those plants supplying not less than 90 percent of a city's milk supply. Prior to September 15, 1961, this composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions.

FIGURE 1.—PASTEURIZED MILK AREA SAMPLING STATIONS, DECEMBER 1961

Editor's note: Rapid City, South Dakota, became a reporting station during April. It will not be indicated on figure 1 until the analytical data are available.

Since September 15, the sampling schedule has been accelerated.

During the second week in September, when increased levels of gross beta radioactivity in air were reported by the Radiation Surveillance Network, the frequency of milk sampling was accelerated at selected stations. Daily sampling of pasteurized milk, with analyses for iodine-131 content, was initiated on September 19, 1961, at six selected stations. These stations are maintained on a daily basis so that the pattern of variation in the iodine-131 content of milk may be carefully studied.

The sampling schedule in effect during the month of December was a transition between the November schedule (see April *RHD*) and the January 1962 schedule of weekly samples at all stations excepting the following which were maintained on the daily basis:

Chicago, Ill.	New York, N. Y.
New Orleans, La.	Austin, Tex.
St. Louis, Mo.	Seattle, Wash.

All surveillance data will be subject to continuing review and evaluation to observe unusual patterns or levels which may require immediate attention and adjustment in the pasteurized milk sampling program operation. Further atmospheric nuclear testing may require an immediate re-evaluation and readjustment of the sampling frequency and analytical schedule for this program.

Iodine-131, cesium-137, and barium-140 are determined by gamma scintillation spectroscopy, while strontium-89 and strontium-90 are determined following radiochemical separation. The minimum levels of detection for strontium-89, strontium-90, iodine-131, cesium-137, and barium-140 in terms of μμc/liter are 5, 1, 10, 5 and 10, respectively.

A comparison was made of cesium-137 concentrations in milk to show that they remain quite constant through the month. A number of milk samples collected during November from locations with high (90 μμc/liter), medium (20 μμc/liter), and low (5 μμc/liter)

TABLE 1.—RADIOACTIVITY IN PASTURIZED MILK, DECEMBER 1961

[Average radioactivity concentrations in $\mu\mu c$/liter]

Area		Calcium (gm/liter)		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
City	State	Fourth quarter	Monthly [a] average	Fourth quarter	Monthly [a] average	Fourth quarter	Monthly [a] average	Fourth quarter	Monthly [a] average	Fourth quarter	Monthly [a] average	Fourth quarter	Monthly [a] average
Montgomery	Ala.	1.22	1.18 (1)	10	20 (1)	6	6 (1)	20	<10 (1)	<5	<5 (1)	10	<10 (1)
Palmer	Alaska	1.10	1.04 (5)	60	20 (5)	12	9 (5)	130	<10 (8)	15	10 (8)	40	<10 (8)
Phoenix	Ariz.	1.05	1.01 (3)	10	20 (3)	6	2 (3)	50	10 (7)	5	5 (7)	<10	<10 (7)
Little Rock	Ark.	1.20	1.22 (5)	70	85 (5)	15	17 (5)	100	20 (9)	20	20 (1)	30	40 (5)
Sacramento	Calif.	1.13	1.11 (3)	10	10 (3)	5	3 (3)	20	10 (7)	10	5 (7)	<10	10 (7)
San Francisco	Calif.	1.09	1.10 (4)	10	15 (4)	3	4 (4)	20	<10 (5)	5	5 (5)	<10	<10 (5)
Denver	Colo.	1.10	1.06 (3)	20	25 (3)	6	7 (3)	50	10 (7)	10	5 (7)	10	<10 (7)
Hartford	Conn.	1.17	1.16 (5)	25	10 (5)	8	7 (5)	30	<10 (5)	10	<5 (1)	20	<10 (5)
Wilmington	Del.	1.17	1.20 (5)	50	20 (5)	10	9 (5)	40	<10 (6)	5	<5 (1)	20	10 (5)
Washington	D. C.	1.17	1.16 (4)	35	20 (4)	9	8 (4)	30	10 (6)	5	<5 (1)	20	<10 (4)
Tampa	Fla.	1.22	1.21 (5)	20	10(5)	6	7 (5)	30	20 (7)	70	40 (1)	20	<10 (5)
Atlanta	Ga.	1.20	1.21 (5)	25	40 (5)	11	12 (5)	50	30 (7)	[b] 5	<5 (1)	20	20 (5)
Honolulu	Hawaii	1.07	1.05 (4)	10	20 (4)	6	11 (4)	20	10 (6)	15	10 (6)	<10	<10 (6)
Idaho Falls	Idaho	1.05	1.03 (4)	25	5 (4)	6	6 (4)	80	10 (6)	10	5 (6)	10	<10 (6)
Chicago	Ill.	1.17	1.16 (5)	55	15 (5)	7	7 (5)	70	<10(20)	[b] 10	<5 (1)	30	<10 (5)
Indianapolis	Ind.	1.21	1.20 (4)	40	20 (4)	8	10 (4)	50	10 (6)	<5	<5 (1)	20	10 (4)
Des Moines	Iowa	1.06	1.04 (4)	65	50 (4)	11	8 (4)	180	30 (9)	10	5 (9)	20	10 (8)
Wichita	Kans.	1.06	1.00 (3)	40	40 (3)	10	10 (3)	100	30(11)	10	10 (7)	10	10 (8)
Louisville	Ky.	1.19	1.19 (5)	45	50 (5)	10	11 (5)	60	20 (7)	<5	<5 (1)	30	20 (5)
New Orleans	La.	1.26	1.28 (5)	110	205 (5)	15	17 (5)	60	30(20)	15	10 (1)	40	40 (5)
Portland	Maine	1.19	1.15 (4)	60	<5 (4)	11	11 (4)	50	<10 (6)	20	20 (1)	40	<10 (4)
Baltimore	Md.	1.17	1.18 (5)	35	30 (5)	8	8 (5)	40	10 (6)	<5	<5 (1)	20	<10 (5)
Boston	Mass.	1.18	1.19 (5)	70	<5 (5)	11	11 (5)	60	10 (6)	10	10 (1)	40	<10 (5)
Detroit	Mich.	1.17	1.15 (5)	45	15 (5)	7	6 (5)	100	<10 (6)	5	<5 (1)	20	<10 (5)
Grand Rapids	Mich.	1.19	1.22 (5)	60	15 (5)	7	7 (5)	50	<10 (6)	<5	<5 (1)	30	10 (5)
Minneapolis	Minn.	1.10	1.14 (3)	110	20 (4)	12	10 (4)	170	10 (9)	15	10 (7)	40	<10 (7)
Jackson	Miss.	1.28	1.31 (5)	95	175 (5)	14	17 (5)	70	50 (8)	5	<5 (1)	40	50 (5)
Pascagoula	Miss.	1.27	1.28 (5)	80	145 (5)	16	18 (5)	60	40 (6)	10	10 (1)	30	30 (5)
Kansas City	Mo.	1.06	1.07 (3)	75	70 (3)	10	12 (3)	130	40 (6)	15	10 (6)	20	10 (6)
St. Louis	Mo.	1.08	1.02 (4)	35	20 (4)	9	8 (4)	90	10(23)	10	10(23)	10	<10(23)
Helena	Mont.	1.07	1.02 (2)	15	5 (2)	8	6 (2)	100	20 (7)	20	15 (5)	10	<10 (5)
Omaha	Nebr.	1.08	1.01 (4)	100	70 (4)	10	7 (4)	140	40 (9)	10	10 (8)	30	10 (8)
Manchester	N. H.	1.20	1.20 (5)	35	5 (5)	12	12 (5)	50	<10 (6)	25	20 (1)	40	<10 (5)
Trenton	N. J.	1.18	1.17 (4)	35	15 (4)	9	8 (4)	40	<10 (6)	<5	<5 (1)	20	20 (4)
Albuquerque	N. Mex.	1.09	1.10 (3)	5	10 (4)	6	4 (4)	30	<10 (6)	10	5 (6)	<10	<10 (6)
Buffalo	N. Y.	1.12	1.11 (5)	35	5 (5)	8	8 (5)	40	<10 (6)	5	10 (1)	20	<10 (5)
New York	N. Y.	1.13	1.12 (5)	40	5 (5)	8	9 (5)	50	<10(19)	5	<5 (1)	30	<10 (5)
Syracuse	N. Y.	1.16	1.13 (5)	50	5 (5)	8	7 (5)	60	<10 (5)	10	<5 (1)	30	<10 (5)
Charlotte	N. C.	1.27	1.29 (5)	25	30 (5)	10	12 (5)	20	<10 (7)	<5	<5 (1)	10	10 (5)
Minot	N. D.	1.09	1.04 (4)	15	5 (4)	11	11 (4)	60	<10 (5)	10	10 (5)	<10	<10 (5)
Cincinnati	Ohio	1.22	1.21 (5)	50	50 (5)	8	10 (5)	70	20 (7)	<5	<5 (1)	30	10 (5)
Cleveland	Ohio	1.18	1.17 (5)	35	10 (5)	7	7 (5)	50	<10 (7)	5	<5 (1)	20	<10 (5)
Oklahoma City	Okla.	1.18	1.19 (5)	60	70 (5)	8	9 (5)	100	40 (5)	10	<5 (1)	20	30 (5)
Portland	Oreg.	1.05	1.02 (4)	70	20 (4)	17	6 (4)	80	10 (6)	25	20 (6)	20	10 (6)
Philadelphia	Pa.	1.20	1.19 (5)	30	10 (5)	8	9 (5)	40	<10 (6)	<5	<5 (1)	10	10 (5)
Pittsburgh	Pa.	1.16	1.18 (5)	40	5 (5)	10	10 (5)	40	<10 (6)	5	<5 (1)	30	10 (5)
San Juan	P. R.	1.18	1.17 (5)	55	130 (5)	5	5 (5)	20	30 (7)	10	30 (1)	20	30 (5)
Providence	R. I.	1.18	1.17 (5)	55	15 (5)	9	9 (5)	40	<10 (6)	10	10 (1)	30	<10 (5)
Charleston	S. C.	1.23	1.26 (4)	15	15 (4)	11	12 (4)	30	10 (5)	20	20 (1)	20	20 (4)
Chattanooga	Tenn.	1.27	1.31 (5)	50	80 (5)	12	16 (5)	50	30 (6)	5	<5 (1)	20	30 (5)
Memphis	Tenn.	1.24	1.24 (5)	60	85 (5)	11	12 (5)	90	40 (5)	10	10 (1)	20	30 (5)
Austin	Tex.	1.18	1.21 (5)	30	65 (5)	5	6 (5)	40	20(19)	[b] <5	<5 (1)	20	20 (5)
Dallas	Tex.	1.23	1.23 (5)	45	60 (5)	9	8 (5)	50	10 (9)	[b] <5	<5 (1)	20	20 (5)
Salt Lake City	Utah	1.11	1.00 (1)	20	15 (1)	5	5 (1)	60	10 (7)	10	10 (5)	10	<10 (5)
Burlington	Vt.	1.18	1.19 (4)	40	5 (4)	9	8 (4)	50	<10 (4)	10	10 (1)	20	<10 (4)
Norfolk	Va.	1.23	1.23 (5)	60	40 (5)	10	11 (5)	40	10 (6)	5	<5 (1)	20	10 (5)
Seattle	Wash.	1.11	1.07 (4)	60	30 (4)	13	8 (4)	80	10(23)	20	15(22)	20	10(22)
Spokane	Wash.	[b] 1.12	1.07 (3)	[b] 10	5 (3)	[b] 6	7 (3)	60	<10 (7)	15	10 (7)	10	10 (7)
Charleston	W. Va.	1.17	1.18 (5)	55	20 (5)	10	11 (5)	30	<10 (6)	<5	<5 (1)	20	10 (5)
Milwaukee	Wis.	1.17	1.06 (5)	35	5 (5)	7	6 (5)	80	<10 (8)	15	20 (1)	20	10 (5)
Laramie	Wyo.	1.09	1.06 (3)	<5	5 (3)	6	5 (3)	30	10 (8)	15	15 (8)	10	10 (8)
Network average		1.16	1.15	43	34	9	9	61	14	11	8	22	12

[a] Numbers in parentheses indicate total number of analyses reported during the month.
[b] Average based on two months.

concentrations were analyzed. The data indicate that cesium-137 levels remain quite constant throughout the month. Therefore, many sampling locations will have only one analysis performed each month for cesium-137.

The strontium-89 concentrations in milk decreased markedly during December in the Northeast and North Central States, but increased in the Southeast, possibly reflecting that dairy cattle in the Northeast and North Central States were taken off pasture feeding and put on feeds harvested prior to the resumption of atmospheric testing. The iodine-131 and barium-140 concentrations continued their decline from previous months while the average strontium-90 concentration for the network did not change.

Figure 2 is a graphical presentation of the average monthly concentrations of strontium-90 in pasteurized milk from selected cities representing the population centers of the four major geographic regions of the United States.

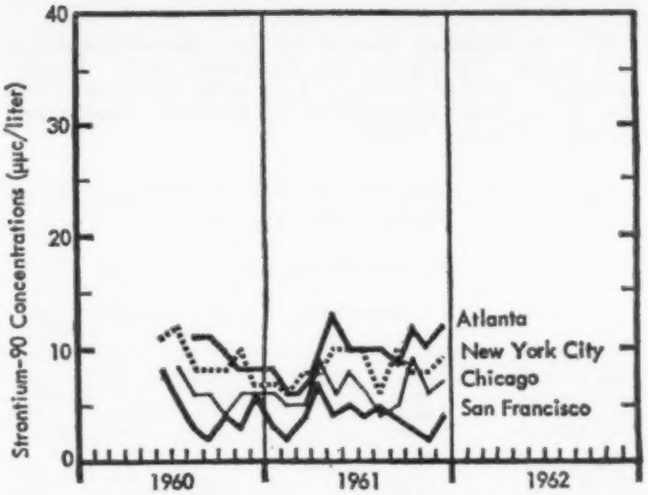

FIGURE 2.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK, JUNE–DECEMBER 1961

These regions correspond to those used by the Department of Agriculture for their tabulations of average "per person" quantities of foods consumed per week, as presented in the September and October 1960 *RHD*.

Table 1 presents a summary of all available analyses for December. The numbers in parentheses indicate the number of samples involved in each average, and are a guide to the reliability of the average for the month. When a radionuclide was not detectable, one half of the minimum level of detection was used for averaging.

Strontium-90 in Canadian Dried Milk Products

Department of National Health and Welfare, Ottawa, Canada

In November 1955, radiochemical analyses of skim milk and buttermilk powders for strontium-90 concentrations were initiated by the Department of National Health and Welfare. Through the cooperation of the Marketing Division of the Canadian Department of Agriculture, dairy products inspectors collect four 1-pound samples of dried milk each month from each station (see figure 1) for the Radioactive Fallout Monitoring Program. No precise control is maintained over the method of sample collection. Whether or not all samples are collected on the same day or if the sample is truly representative of the milk produced in a given area is not known.

FIGURE 1.—CANADIAN DRIED MILK SAMPLING STATIONS

Because of the sampling uncertainties introduced by the method of sampling, the significance of differences between results from station-to-station and month-to-month are not precisely known. It is possible, however, to consider all the results for a given period of time as being sufficiently random in selection to show any national trend when the average values for such periods and all stations are plotted. Such a plot is shown in figure 2. It should be emphasized that average levels over a considerable period of time are more meaningful from the public health point of view than fluctuating monthly levels.

A detailed discussion of the sampling and radiochemical methodology may be found in the Department's publication (*1*).

Table 1 presents the results of measurements of strontium-90 in Canadian dried milk

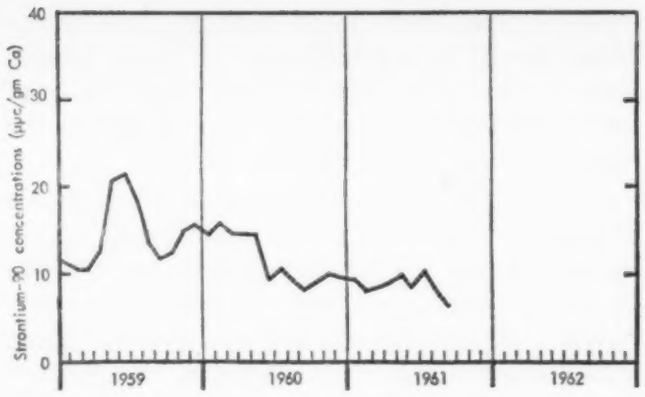

FIGURE 2.—AVERAGE STRONTIUM-90 CONCENTRATIONS IN CANADIAN DRIED MILK PRODUCTS

powder for the third quarter of 1961. This table was taken from the "Quarterly Report of the Radioactive Fallout Monitoring Program," dated January 1962, published by the Radiation Protection Division of the Department of National Health and Welfare. Monthly data for the years 1960 and 1961 have been published in previous issues of *Radiological Health Data*.

BIBLIOGRAPHY

(*1*) "Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples," *CNHW (RP–1)*, July 1958, Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada.

TABLE 1.—STRONTIUM-90 IN CANADIAN DRIED MILK POWDER, 1961

[Concentrations in μμc/gm Ca]

Station	Type of milk	July	August	September
Calgary	Skim	5.9	5.6	4.6
Charlottetown	Skim	[1] NS	NS	NS
Chicoutimi [2]	Skim	15.7	14.4	14.3
E. Florenceville	Skim	16.2	9.8	NS
Edmonton	Skim	6.9	5.8	4.2
Granby	Skim	11.6	12.4	7.8
Halifax	Skim	11.4	7.3	7.1
La Durantaye	Skim	15.0	11.4	9.8
London	Skim	4.1	2.8	2.3
Megantic	Skim	18.4	12.0	11.1
Moncton	Buttermilk	10.3	8.2	7.0
Ottawa	Skim	6.2	4.9	3.5
Saskatoon	Buttermilk	5.4	3.0	3.0
Sussex	Skim	10.5	9.4	7.6
Vancouver	Skim	10.6	5.6	5.7
Walkerton	Skim	4.4	5.5	3.3
Winnipeg	Buttermilk	NS	3.5	3.5
Average		10.2	7.6	6.3

[1] NS = no milk powder received for the month.
[2] Chicoutimi stopped production. Milk powder sampled from Mistassini on opposite shore of Lac St. Jean.

SECTION III.—WATER

National Water Quality Network

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network operates under the provision of Section 4 (c) of the Federal Water Pollution Control Act, which states, ". . . The Secretary shall . . . collect and disseminate basic data . . . (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local agencies and industrial organizations, commenced operations in October 1957. During November 1961, 94 sampling stations submitted water samples for analyses. These stations are located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial, and other uses. Some of these stations are on interstate, coastal, and international boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of approximately 300 stations will be in operation. Radioactivity is not yet being reported for a few of the more recently established stations.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium-90 on the total solids only) in raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of the levels which may be found in treated water, where such water treatment removes substantially all of the suspended matter. Naturally-occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing for a period of three years, the beta activity in most raw waters generally had approached a level attributable solely to natural sources. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. The resumption of nuclear weapons testing in the atmosphere by the U.S.S.R. has resulted in an increase in radioactivity of surface waters.

For the first two years of the Network operations, beta determinations were made on weekly samples. Alpha determinations were reported generally on composites of more than one weekly sample. Since January 1959, a portion of each sample from all stations in the

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in $\mu\mu c$/liter]

Station	Quarter ending Sept. 30, 1961	November 1961					
	Strontium-90	Beta activity			Alpha activity		
	Total	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa.	0.3	0	12	12	0	0	0
Animas River: Cedar Hill, N. Mex.	0.3	8	30	38	1	8	9
Apalachicola River: Chattahoochie, Fla.	0.4	16	30	46	0	0	0
Arkansas River:							
Coolidge, Kansas	2.3	28	81	109	5	76	81
Ponca City, Okla.	[a] —	122	87	209	1	4	5
Pendleton Ferry, Ark.	—	74	24	98	7	0	7
Big Sioux River: Sioux Falls, S. Dak.	0.4	53	127	180	2	2	4
Chattahoochie River:							
Atlanta, Ga.	—	4	5	9	0	0	0
Columbus, Ga.	—	1	5	6	0	0	0
Clear Water River: East Lewiston, Idaho	—	16	28	44	<1	<1	<1
Colorado River:							
Loma, Colo.	—	36	48	84	7	8	15
Boulder City, Nev.	1.0	7	13	20	<1	9	9
Parker Dam, Calif.	—	2	34	36	0	9	9
Yuma, Ariz.	—	30	66	96	2	0	2
Columbia River:							
Wenatchee, Wash.	—	2	7	9	0	1	1
Pasco, Wash.	1.1	61	687	748	0	0	0
Bonneville Dam, Oreg.	[b] 0.6	20	249	269	—	—	—
Clatskanie, Oreg.	—	14	155	169	—	—	—
McNary Dam, Oreg.	1.2	50	440	490	0	1	1
Connecticut River: Northfield, Mass.	0.4	6	16	22	0	0	0
Cumberland River: Clarksville, Tenn.	0.4	4	10	14	0	0	0
Delaware River:							
Martins Creek, Pa.	—	10	18	28	0	0	0
Trenton, N. J.	—	41	36	77	1	0	1
Escambia River: Century, Fla.	[b] 0.9	12	4	16	0	0	0
Great Lakes:							
Buffalo, N. Y.	—	6	9	15	0	0	0
Detroit, Mich.	[b] 0.6	4	8	12	0	0	0
Port Huron, Mich.	0.4	2	5	7	0	0	0
Milwaukee, Wis.	—	8	12	20	0	0	0
Sault Ste. Marie, Mich.	—	4	6	10	0	0	0
Gary, Ind.	0.2	14	10	24	1	0	1
Duluth, Minn.	—	2	4	6	0	0	0
Hudson River: Poughkeepsie, N. Y.	0.2	4	9	13	0	0	0
Illinois River:							
Peoria, Ill.	0.4	31	37	68	2	2	4
Grafton, Ill.	—	179	55	234	5	1	6
Kanawha River: Winfield Dam, W. Va.	—	7	15	22	0	0	0
Klamath River: Copco, Oreg.	—	11	14	25	0	0	0
Little Miami River: Cincinnati, Ohio	1.1	52	57	109	<1	<1	1
Merrimack River: Lowell, Mass.	[b] 0.7	—	—	—	—	—	—
Mississippi River:							
St. Paul, Minn.	0.9	21	59	80	0	1	1
Dubuque, Iowa	—	31	36	67	—	—	—
Burlington, Iowa	0.6	44	38	82	0	6	6
E. St. Louis, Ill.	—	41	25	66	1	0	1
Cape Girardeau, Mo.	0.8	138	54	192	8	2	10
West Memphis, Ark.	—	59	31	90	1	1	2
Delta, La.	[b] 0.4	58	28	86	4	1	5
New Orleans, La.	—	17	21	38	1	1	2
Vicksburg, Miss.	—	88	36	124	2	2	4
Missouri River:							
Williston, N. Dak.	—	26	37	63	1	5	6
Bismarck, N. Dak.	—	20	24	44	1	1	2
Yankton, S. Dak.	0.6	—	—	—	—	—	—
Omaha, Nebr.	—	45	78	123	0	2	2
St. Joseph, Mo.	—	228	167	395	2	5	7
Kansas City, Kansas	—	96	70	166	2	3	5
St. Louis, Mo.	1.4	70	40	110	3	1	4
Monongahela River: Pittsburgh, Pa.	0.4	5	19	24	<1	<1	1
North Platte River: Henry, Nebr.	—	28	74	102	1	28	29
Ohio River:							
East Liverpool, Ohio	0.4	28	23	51	2	0	2
Huntington, W. Va.	—	22	13	35	0	0	0
Cincinnati, Ohio	—	9	20	29	0	1	1
Louisville, Ky.	0.4	2	18	20	<1	<1	1
Evansville, Ind.	—	12	22	34	0	0	0
Cairo, Ill.	1.1	—	—	—	—	—	—
Ouachita River: Bastrop, La.	—	37	49	86	1	1	2
Potomac River:							
Williamsport, Md.	—	21	32	53	0	0	0
Great Falls, Md.	—	13	29	42	1	1	2
Platte River: Plattsmouth, Nebr.	—	62	64	126	3	7	10
Rainy River: International Fls., Minn.	—	6	14	20	0	0	0
Red River, North: Grand Forks, N. Dak.	—	12	49	61	1	2	3
Red River, South:							
Denison, Tex.	—	10	13	23	0	3	3
Alexandria, La.	1.0	21	36	57	2	0	2
Rio Grande River:							
Alamosa, Colo.	[b] 0.4	2	13	15	0	1	1
Laredo, Tex.	—	44	27	71	2	3	5
Brownsville, Tex.	—	14	20	34	1	8	9

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Concentrations in μμc/liter]

Station	Quarter ending Sept. 30, 1961	November 1961					
	Strontium-90	Beta activity			Alpha activity		
	Total	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Roanoke River: John H. Kerr Reservoir & Dam, Va.	—	0	6	6	0	0	0
Sabine River: Ruliff, Tex.	—	17	24	41	<1	0	<1
San Juan River: Shiprock, N. Mex.	—	79	59	138	8	13	21
St. Lawrence River: Massena, N. Y.	—	5	16	21	0	0	0
Schuylkill River: Philadelphia, Pa.	—	0	3	3	—	—	—
Savannah River:							
Port Wentworth, Ga.	0.4	3	16	19	—	—	—
North Augusta, S. C.	—	3	4	7	0	0	0
Shenandoah River: Berryville, Va.	—	10	22	32	0	<1	<1
Snake River:							
Wawawai, Wash.	0.3	8	18	26	—	—	—
Payette, Idaho	—	13	24	37	0	4	4
South Platte River: Julesburg, Colo.	0.7	29	52	81	2	38	40
Susquehanna River:							
Sayre, Pa.	0.3	13	25	38	0	0	0
Conowingo, Md.	0.3	2	14	16	0	0	0
Tennessee River:							
Pickwick Landing, Tenn.	—	6	20	26	0	0	0
Chattanooga, Tenn.	0.6	3	14	17	0	0	0
Bridgeport, Ala.	0.7	4	18	22	0	0	0
Tombigbee River: Columbus, Miss.	—	30	20	50	<1	0	<1
Truckee River: Farad, Calif.	—	26	22	48	0	1	1
Yakima River: Richland, Wash.	0.4	3	10	13	0	2	2
Yellowstone River: Sidney, Mont.	—	24	29	53	1	6	7

[a] Dash denotes no samples received or no determinations made.
[b] April–September strontium-90 data.

Network has been composited into a three-month sample for measurement of strontium-90 concentration.

Beginning January 1, 1960, the frequency of beta determinations varied depending on the status of each particular station. For the first operating year of each new station, analyses were being conducted weekly. Weekly analyses were to be continued indefinitely for all stations which may be affected by waste discharges from nuclear installations. Semimonthly determinations (on composites of 2 or 3 weekly samples) were conducted for stations which still showed some beta activity above background. Monthly determinations (on composites of all samples received from a station during the month) were conducted on samples from streams where beta activity was at background levels.

Beginning January 1, 1960, the frequency of alpha determinations also was changed. For the first operating years of each new station, analyses were to be done weekly. At some stations on the Colorado and Animas Rivers determinations were done on weekly samples or semimonthly on two- or three-week composites. The remainder of the stations were scheduled so that each made one gross alpha determination per month.

Following the resumption of nuclear weapons testing in the atmosphere by the U.S.S.R., the gross beta and alpha determination schedules were altered. Beginning September 1, 1961, gross beta determinations are to be made on all samples collected (compositing weekly samples for monthly or semimonthly gross beta or alpha determinations will cease). Beginning October 1, 1961, gross alpha determinations are to be made on one sample from each station each month, unless there is evidence of alpha activity in excess of background levels. In the latter instance, an alpha determination will be made on a weekly or bi-weekly basis, depending on what is considered the norm for a particular station.

All data reported in table 1 represent the average of all data reported for the period indicated. The reported strontium-90 data are the results of determinations on three-month composite samples for the quarter ending in the month shown.

Additional information and data may be obtained from the following sources:

(1) *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, Water Years 1957–58, 1958–59, 1959–60. Public Health Service, Division of Water Supply and Pollution Control, Washington 25, D. C.

(2) "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167–169.

(3) Setter, L. R., J. E. Regnier, and A. Diephaus, "Radioactivity of Surface Waters in the United States," *Journal of the American Water Works Association*, 51, 1377 (1959).

(4) Straub, C. P., L. R. Setter, A. Goldin, and P. F. Hallbach, "Strontium–90 in Surface Waters," *Journal of the American Water Works Association*, 52, 756 (1960).

(5) Setter, L. R., and S. L. Baker, "Radioactivity of Surface Waters in the United States," *Radiological Health Data*, Vol. I, No. 7 (1960).

(6) Straub, C. P., "Significance of Radioactivity Data," *Journal of the American Water Works Association*, 53, 704 (1961).

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, NOVEMBER 1961

Drinking Water Standards For Radioactivity

Division of Environmental Engineering and Food Protection
Public Health Service

Revision of the 1946 edition of the Public Health Service "Drinking Water Standards" became effective April 5, 1962. For the first time, these standards include permissible limits on radioactivity concentrations in municipal water supplies used by interstate carriers. Certification of these water supplies by the Surgeon General of the Public Health Service is required by law.

The Public Health Service "Drinking Water Standards" were first adopted in 1914 to protect the health of the traveling public. Since

that time, the standards have become applicable to water supplies generally, and there has been a series of revisions. Technological advances, including the development of atomic energy, required that these Standards again be revised; an Advisory Committee was appointed to do so in 1959. This Advisory Committee consisted of representatives from Federal agencies, scientific associations, and industry. The American Water Works Association has endorsed the revised Standards and has recommended their use for all public water supplies.

The Drinking Water Standards which apply to radioactivity are concerned specifically with strontium-90, radium-226, and gross beta activity. Water supplies will be approved if they contain less than 3 μμc/liter of radium-226 and less than 10 μμc/liter of strontium-90. If either of these concentrations are exceeded, the water supply will not be approved by the certifying authority until the surveillance of total intakes of strontium-90 and radium-226 from all sources indicates that such intakes are within the limits recommended by the Federal Radiation Council for control action.

In the known absence of strontium-90 and alpha emitters (absence is taken to mean a negligibly small fraction of the specified limits with radium-226 used for alpha), the water supply is acceptable when gross beta concentrations do not exceed 1,000 μμc/liter. Gross beta concentrations in excess of 1,000 μμc/liter shall constitute grounds for rejection of the supply except when more complete analyses indicate that concentrations of nuclides are not likely to cause exposures greater than the Radiation Protection Guides recommended by the Federal Radiation Council.

Recommended radiochemical procedures may be found in "Manual of Methodology, Radionuclide Analyses of Environmental Samples," *Technical Report R59–6*, Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio; and "Methods of Radiochemical Analysis," *Technical Report No. 173*, Report of the Joint WHO-FAO Committee, 1959, World Health Organization.

The 1962 Public Health Service Drinking Water Standards may be obtained from the Water Supply Activity, Interstate Carrier Branch, Public Health Service, Washington 25, D. C.

Drinking Water Analysis Program

Division of Environmental Engineering and Food Protection
Public Health Service

The Water Supply Activity of the Interstate Carrier Branch, Division of Environmental Engineering and Food Protection, PHS, has gathered extensive data on the radioactivity content of water supplies used on interstate carriers such as trains, airplanes, ships and other conveyances operating in interstate commerce. This work has several objectives, among which are:

1. to determine radioactivity content of interstate carrier water supplies for comparison with the revised Public Health Service Drinking Water Standards.
2. to establish the radioactivity background level as the base with which to compare future results from the supplies sampled.
3. to obtain data for study in connection with the occurrence of certain chronic diseases.

Beginning in November 1960, the project is a continuing one under which it is planned to cover ultimately the 850 U. S. water supplies used by interstate carriers. Figure 1 shows the nationwide distribution of the 140 municipalities included in the first sampling. In many instances, there are several sources for a

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municipality and each is sampled. Water supply sampling for a second group of cities is underway at the present time. When this is complete, another group of about 100 will be chosen.

Each sample is a composite of four aliquots a day obtained during a two week period. The analyses for gross alpha, gross beta, and strontium-90 are performed at the Southeastern and Southwestern Radiological Health Laboratories, operated by the Division of Radiological Health.

Table 1 presents partial data from the first sampling. The data will be published on a regular basis as it becomes available.

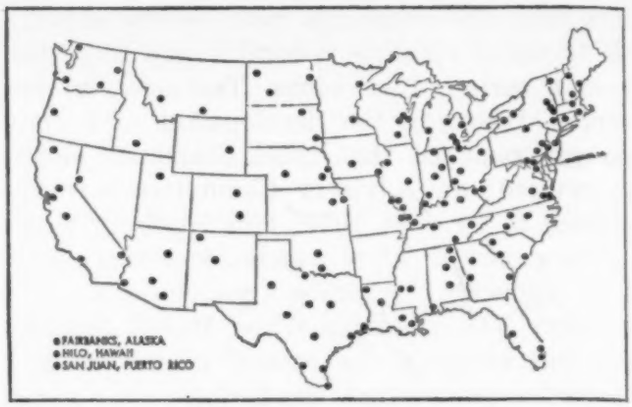

FIGURE 1.—DRINKING WATER ANALYSIS PROGRAM SAMPLING STATIONS

TABLE 1.—RADIOACTIVITY IN DRINKING WATERS

[Concentrations in μμc/liter]

Station	Population served	Date sampled	Strontium-90	Alpha activity			Beta activity		
			Total solids	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Sayre, Pennsylvania[a]	12,000	6/2-16/61	[b]—	0.5	0.5	1.0	3.0	3.0	6.0
Cairo, Illinois[a]	10,000	2/16-3/13/61	0.3	—	12.0	—	—	2.6	—
Chester, Illinois	5,400	2/15-3/2/61	0.6	—	0.5	—	—	3.6	—
Decatur, Illinois	78,000	7/11-26/61	—	—	—	—	3.0	3.0	6.0
Rock Island, Illinois	52,000	7/12-26/61	—	0.5	0.5	1.0	3.0	3.6	6.6
East St. Louis, Illinois[a]	250,000	2/14-28/61	0.9	—	0.5	—	—	3.3	—
Green Bay, Wisconsin	64,000	5/16-6/3/61	—	0.5	0.5	1.0	3.0	3.0	6.0
Madison, Wisconsin	135,000	7/18-8/1/61	—	—	—	—	3.0	3.8	6.8
Manitowoc, Wisconsin	31,600	5/17-31/61	—	0.5	0.5	1.0	3.0	3.0	6.0
Neenah, Wisconsin	18,100	5/18-6/3/61	—	0.5	0.5	1.0	3.0	2.9	5.9
Duluth, Minnesota[a]	108,000	7/21-8/11/61	—	0.5	0.5	1.0	1.0	2.0	3.0
Denver, Colorado	612,000								
Infiltration Gallery	—	2/15-3/2/61	—	—	—	0.9	—	—	2.7
Kassler Plant	—	2/15-3/1/61	—	—	—	0.7	—	—	3.1
N. Marston Lake Plant	—	2/15-3/2/61	—	—	—	<0.5	—	—	3.1
S. Marston Lake Plant	—	2/15-3/2/61	—	—	—	0.8	—	—	2.7
Moffat Plant	—	2/14-3/3/61	—	—	—	0.6	—	—	2.2
Pueblo, Colorado	110,000								
North Side Plant	—	5/25-6/9/61	—	—	—	<0.5	—	—	1.8
South Side Plant	—	5/25-6/9/61	—	—	—	<0.5	—	—	2.2
Twin Falls, Idaho	21,000								
City Treatment Plant	—	5/2-17/61	—	—	—	<0.5	—	—	3.6
Johnston Well	—	5/2-29/61	—	—	—	<0.5	—	—	2.9
Billings, Montana	65,500	1/17-31/61	—	—	—	1.5	—	—	3.2
Butte, Montana	50,000								
Basin Creek	—	1/19-2/5/61	—	—	—	0.7	—	—	2.4
Big Hole	—	1/19-2/3/61	—	—	—	1.1	—	—	2.2
Salt Lake City, Utah	275,000								
Big Cottonwood	—	3/21-4/22/61	—	—	—	<0.5	—	—	1.3
City Creek	—	3/22-4/5/61	—	—	—	<0.5	—	—	<0.5
3rd E. Pumping Station	—	3/21-4/5/61	—	—	—	1.1	—	—	2.9
15th E. Pumping Station	—	3/22-4/5/61	—	—	—	1.2	—	—	3.0
Little Cottonwood	—	3/23-4/10/61	—	—	—	<0.5	—	—	4.3
Casper, Wyoming	15,700	11/17-12/5/60	—	—	—	1.1	—	—	2.4

[a] Location also sampled by National Water Quality Network.

[b] Dashes indicate no determination reported (usually, strontium-90 is not determined unless gross beta exceeds 10μμc/liter).

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SECTION IV.—OTHER DATA

Considerations in Establishing Radiation Protection Standards for Radioactivity in the Environment[1]

Donald R. Chadwick, M.D. and Conrad P. Straub, Ph.D.[2]

Introduction

In considering the technical aspects of the problems of establishing permissible levels of intake from environmental sources, it is appropriate to mention the organizational arrangements of the United States Government for the establishment of basic radiation protection standards. Recognition of the need for action by the Government came from an evaluation of the nature of the decisions involved in the establishment of basic radiation protection standards. At one time these standards were based upon the concept of tolerance dose, defined as a dose which when received by exposed individuals, would produce no deleterious biological effects. Under this concept, known as the threshold hypothesis, development of radiation protection standards was a scientific job involving the determination of the radiation dose below which effects would not occur.

In recent years, however, evidence has been accumulating which casts doubt on the assumption that it is possible to determine a safe dose—if by safe dose one means a dose which, even when used as a protection standard for a large population, will produce no harm in any individual. Evidence on the genetic effects of radiation indicates that even small doses of radiation delivered to the gonads prior to reproduction will be accompanied by an increase in genetic mutations, most of which are deleterious. With respect to the somatic effects, it is not clear whether small doses have a permanent injurious effect or not. In the establishment of radiation protection standards, therefore, it appears necessary to assume that any radiation dose is accompanied by an increased risk of deleterious biological effects, the magnitude of which increases with the dose. This hypothesis is generally referred to as the no-threshold hypothesis of dose-effect relationships.

Under the no-threshold hypothesis, the establishment of radiation protection standards requires acceptance of a certain risk of deleterious biological effects with any dose chosen as a standard. There must be a reason for accepting such a risk and this reason is sought in

[1] Presented at Fourth Inter-American Symposium on the Peaceful Application of Nuclear Energy, Mexico City, Mexico, April 9–13, 1962.

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what has been termed "the benefits to be derived." Thus the benefits to be expected as a result of the radiation exposure must outweigh the potential risk or hazard. Or, looking at the situation from a slightly different vantage point, the reasons for accepting or permitting a particular level of exposure, rather than requiring the exposure to be reduced to a lower level, must outweigh the decrease in risk to be expected from the reduction in exposure.

Thus, the establishment of basic radiation protection standards is not strictly a scientific task. Scientific data are involved in the decision, but the decisions rest on achieving a balance between benefit and risk. The task involves the exercise of judgment, the nature of which has been expressed in the following language: "Fundamentally, setting basic radiation protection standards involves passing judgment on the extent of the possible health hazard society is willing to accept in order to realize the known benefits of radiation. It involves inevitably a balancing between total health protection which might require foregoing any activities increasing exposure to radiation and atomic energy in order to achieve optimum benefits."[1]

Decisions represented by basic radiation protection standards, therefore, are matters of public policy, and arrangements have been made within the United States Government for the establishment of this policy. The Federal Radiation Council was established in 1959 to advise the President with respect to radiation matters directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards. Members of the Council are the heads of the Federal agencies most significantly involved in radiation: Department of Health, Education, and Welfare, Atomic Energy Commission, Department of Defense, the Department of Commerce, and Department of Labor.

Terminology in the Application of Radiation Protection Standards

One of the problems in the application of radiation protection standards has been misunderstandings among members of the general public as to the nature of these standards. Radiation doses considered to represent an acceptable risk, under a given set of circumstances, have for many years been referred to as maximum permissible doses. Similarly, concentrations of various radioactive materials in air, water, or food, which are calculated to deliver the maximum permissible doses, have been referred to as maximum permissible concentrations. Although workers in the radiation protection field understand what is meant by the terms "maximum permissible," the Federal Radiation Council has felt that the expression may be misleading to the public. In particular, such terms tend to convey the impression that the doses are absolute limits below which exposed individuals are safe and above which dire consequences will ensue.

In an effort to forestall such misinterpretations, the Council uses the term "Radiation Protection Guide" in place of "Maximum Permissible Dose."[1] Consistent with the discussion of the basis for radiation protection standards, a radiation protection guide might be thought of as a radiation dose rate for indefinite exposure established for a given set of circumstances such that the benefits to be derived from applications conducted in a manner so as not to exceed that dose outweigh the potential hazard or risk. Recommended "Radiation Protection Guides" applicable to the radiation worker and the population are shown in Tables 1 and 2.

TABLE 1.—RADIATION PROTECTION GUIDES—RADIATION WORKER

Type of exposure	Condition	Dose (rem)
(a) Whole body, head and trunk, active blood-forming organs, gonads, or lens of eye.	Accumulated dose	5 times number of years beyond age 18.
	13 weeks	3.
(b) Skin of whole body	Year	30.
	13 weeks	10.
(c) Hands and forearms, feet and ankles.	Year	75.
	13 weeks	25.
(d) Bone	Body burden	0.1 microgram of radium-226 or its biological equivalent.
(e) Other organs	Year	15.
	13 weeks	5.

TABLE 2.—RADIATION PROTECTION GUIDES—POPULATION

Type of exposure	Condition	Dose, rem
(a) Individual	Year	0.5 (whole body).
(b) Average	30 years	5 (gonads).

Factors Involved in the Establishment of Concentration Values for Foods, Air, and Water

Permissible levels, or concentration values (to use a term which may reduce misunderstandings) for individual items of food, air, or water are established to achieve the basic objective of the control of population exposure from radionuclides in the environment. These levels provide reasonable assurance that appropriate radiation doses or radiation protection guides are not exceeded. There are two basic methods by which this control is accomplished: restrictions on the entry of radioactive materials into the environment (source control) and measures taken in the environment after the materials have been released and spread designed to limit the intake of such materials by members of the general population (environmental control).

These two different methods of control involve fundamentally different considerations. In general, routine control is exercised through source control. Limits for source control are based on two considerations: (1) the benefits derived from useful applications of radiation and atomic energy justify the risk associated with the routine release of radioactivity to the environment, and (2) the routine release of radioactivity is limited to a value such that the additional reduction in hazard to be expected from lower limits would be too small to justify the additional impact of lower limits. This additional impact may be related to the problems associated with the kinds of measures which might be necessary to restrict release of materials from the source. Consistent, well-regulated, and effective source control usually will prevent the necessity from arising for consideration of environmental control. Examples of such source control are filtration and washing of gaseous wastes containing particulates, aerosols, and gaseous radioactive materials before release to the atmosphere and treatment, recovery, and containment of liquid and solid radioactive wastes.

Any environmental control involves significant difficulties in application. Therefore, the application of environmental controls demands consideration of the impact of these controls on the population and an assessment of this impact in relation to the risks of radiation exposure. For example, the ultimate environmental control, condemnation of water or food supplies, may involve very important health as well as social and economic considerations.

As stated above, the objective of the control of environmental radioactivity is to provide reasonable assurance that radiation protection guides are being met. The most direct means of evaluating the effectiveness of control measures is the determination of the amount of specific radioactive materials in the bodies of members of exposed population groups in order to compare these values with appropriate radiation protection guides for individuals. However, it is not always practical to monitor body burdens resulting from environmental contamination solely by the use of direct measurements on the human body, its tissues, or excreta. Furthermore, it is usually desirable to predict the significance of environmental contamination with radioactive materials without waiting until they accumulate in exposed individuals. One approach toward this end is exemplified by current infant retention studies in our laboratories. Body burdens are determined from differences in intake and excreta. These, or similar studies, provide the basis for predicting uptake of radioactive materials ingested at environmental levels and extrapolation to potential dose effects.

Routine control practice, therefore, generally involves calculation or determination of actual or potential concentrations of the various radioactive materials in air, water, and food, which correspond to appropriate radiation protection guides for suitable samples of exposed population groups. Control actions should be based on an evaluation of population exposure from all of these different environmental media with respect to appropriate radiation protection guides. The average total daily intake of the various radioactive materials from all sources by exposed population groups constitutes an appropriate criterion for this evaluation. Recent recommendations of the Federal Radiation Council, approved by the President, provide guidance in connection with transient rates of daily intake of radioactive material.[2] Rather than providing a single numerical guide for daily intake, the Council has given three ranges of transient rates of daily intake.

The Basis for the Graded Approach to Evaluation of Environmental Radioactivity

A continuous, or average daily intake can be calculated which is estimated to result, under specified conditions, in whole body or organ doses equal to a specified Radiation Protection Guide. Actual intakes of radioactive materials, however, could fluctuate very widely around this average value and still result in an annual dose which would not exceed the specified RPG. Here is one reason for the need for something other than a single numerical value as a basis for evaluation of daily intake.

As previously mentioned, control of intake involves two general methods: source control and environmental control. Within these categories are many different actions whose character and import vary widely from those which entail little interferences with usual activities, such as monitoring and surveillance, to those which involve a major disruption, such as condemnation of water or food supplies. Actions such as changes in water supplies or food production techniques may require prolonged lead times before becoming effective. For these and other reasons, the Federal Radiation Council decided that there was a need for a graded series of appropriate actions related to different ranges of intake of radioactive material by exposed population groups. In its second report, published in September 1961, the Council has developed such a graded approach.[3] The intake values corresponding to Ranges I, II, and III for iodine-131, radium-226, strontium-90, and strontium-89 are listed in Table 3. Table 4 summarizes the actions to be taken relative to each of these ranges of intake.

TABLE 3.—RADIATION PROTECTION STANDARDS—FEDERAL RADIATION COUNCIL

Nuclide	Critical organ	Intake levels, $\mu\mu c$/day		
		Range I	Range II	Range III
I^{131}	Thyroid	0-10	10-100	100-1,000
Ra^{226}	Bone	0-2	2-20	20-200
Sr^{90}	Bone and bone marrow	0-20	20-200	200-2,000
Sr^{89}	Bone and bone marrow	0-200	200-2,000	2,000-20,000

TABLE 4.—RADIATION PROTECTION STANDARDS—FEDERAL RADIATION COUNCIL

Range	Remarks
I	Calculations, based on source information. Surveillance adequate to confirm calculations.
II	Surveillance adequate to demonstrate levels. Control at source to avoid excess exposure as levels increase to top of Range II. Intakes do not exceed RPG values.
III	Surveillance to check effect of control actions. Control designed to reduce levels to Range II or lower. Intakes in Range III will result in exposures exceeding RPG if continued for a sufficient period of time.

Concentration Values in Food, Water, and Air

Many additional factors, some of which are subject to wide variation, must be considered in establishing concentration values for various sources of intake. While it is theoretically possible to calculate a single concentration value for ingestion to be the average concentration of a radioactive material present uniformly in all sources of ingestion which would conform to a given intake and its associated RPG, such a concentration value would not always be applicable in practice. Single concentration values may be relevant in source control where one is considering the controlled release of radioactive material in such a manner so as not to exceed appropriate RPG's. In environmental control, where the relative contribution of different sources of intake must be assessed, the single numerical value for concentration is limited in its application.

Radioactive materials may enter the body from any one or a combination of the three environmental media: air, water, and food. In any specific situation, before an appropriate concentration value can be developed for a specific medium, the relative contribution to total intake from the other media must be estimated. Although in some situations the problem may be simplified because most intake occurs from a single source, in many instances combinations of intake from water and food or air and food may occur. Data on the intake of calcium and strontium-90 from air, water, and food in Table 5 shows that food is the most important source of strontium-90.[4] In other instances, the contribution from water may be increased somewhat, particularly if cistern water supplies are used. Even when most intake is occurring in food, widely varying concentration values applying to different items

TABLE 5.—ENVIRONMENTAL SOURCES OF CALCIUM AND STRONTIUM-90 INTAKE IN CINCINNATI, 1958–59

Source	Estimated weekly intake	Calcium		Strontium-90	
		Weight	Per cent	Weight	Per cent
		gm./week		μμc/week	
Air	140 m³			5.6	5.2
Water	7 liters	0.4	5.0	5.6	5.2
Food	(10.1 kg.)[a]	(7.6)	(95.0)	(96.5)	(89.6)
Milk	3.5 kg.	4.2	52.6	42.0	39.0
Other dairy products[b]	0.3 kg.	1.0	12.5	12.4	11.5
Vegetables	2.6 kg.	1.0	12.5	23.7	22.0
Meat, sea foods, and eggs	2.6 kg.	0.7	8.8	5.9	5.4
Cereals and pastries	0.9 kg.	0.4	5.0	9.5	8.8
Other	0.9 kg.	0.3	3.7	3.0	2.8
Totals					
Per week		8.0	100.0	107.7	100.0
Per day		1.1		15.4	

[a] Totals in parentheses.
[b] Exclusive of milk.

in the diet may be appropriate. Strontium-90 levels observed in selected items of the diet are listed in Table 6.[5] The point here might be clarified by an example. The following, taken from Federal Radiation Council's Staff Report No. 2,[2] are some of the considerations which may be involved in the determination of specific levels at which actions, such as the condemnation of certain food supplies, would take place:

1. Relative proportion of the total diet by weight represented by the item in question. It is quite apparent that a relatively high concentration of a radioactive material in an item such as pepper could produce a lower total daily intake than a much smaller concentration in an item such as milk. Referring again to Table 5, it is seen that meat, sea food, and eggs, which represent about one-fourth of the intake contribute only 1/16 of the strontium-90 to the diet, whereas milk, which represents about ⅓ of the dietary intake, accounts for 7/16 of the strontium-90 intake.
2. The importance of the particular item in nutrition and the availability of substitutes having the same nutritional properties, or perhaps stockpiles of uncontaminated foods. As previously emphasized, any consideration of possible condemnation of foods must involve an assessment of the health hazards which might result from the restriction of vital dietary elements. Many complex factors enter here. The area involved in the contamination, for example, may be very important. Different considerations would certainly be involved in the condemnation of, for in-

TABLE 6.—STRONTIUM-90 CONTENT OF VARIOUS FOOD ITEMS

Food	Year	Number of observations	Sr^{90}, μμc/kg (orig. weight)
Cabbage	1958	6	18 - 315
	1958–59	6	2.0- 14
	1959	20	1 - 48
	1960	12	1.1- 25
	1961	1	6.0
Lettuce	1958	3	5 - 21.1
	1958–59	5	5.4- 970
	1959	5	1.4- 60
	1960	17	1.1- 17
	1961	1	0.3
Tomatoes	1958	1	2.2
	1959	7	2 - 13
	1960	22	0.5- 9.9
Corn	1958	3	0 -1470
	1959	9	0.2- 6.0
	1960	1	0.31
Potatoes	1958	3	4.1- 12.3
	1958–59	6	0.5- 7.3
	1959	15	0.4- 8.2
	1960	7	0.4- 6
Apples	1958	3	2.7- 66
	1959	10	0.4- 6.9
	1960	10	0.2- 2.8
Barley	1958	2	105 - 314
	1959	2	25 - 53
	1959–60	1	54
	1960	1	59
Oats	1958–59	3	10 - 164
	1959	2	17 - 86
	1959–60	1	81
	1960	1	24
Rice	1958	1	2.1
Wheat	1958	32	22 - 140
	1958–59	11	4.8- 520
	1959	70	9 - 196
	1960	9	4 - 53
Wheat:			
Flour, white	1959	1	25.2
Flour, whole wheat	1959–60	2	48 - 56

TABLE 7.—CONCENTRATION OF RADIONUCLIDES AND POTASSIUM IN MILK AT TIME OF COLLECTION—OREGON STATE UNIVERSITY STUDY

Date—December 1961	Pasture cattle				Barn cattle			
	I^{131} μμc/l	Ba^{140} μμc/l	Cs^{137} μμc/l	K gm/l*	I^{131} μμc/l	Ba^{140} μμc/l	Cs^{137} μμc/l	K gm/l*
1	×	×	0	1.7	×	×	10	1.4
2	×	×	20	1.6	×	×	10	1.5
3	110	230	20	1.1	—	—	—	—
4	270	90	30	1.1	×	×	0	1.4
5	210	120	40	1.2	×	×	20	1.3
6	180	130	40	1.2	×	×	10	1.6
7	160	150	40	1.1	×	×	10	1.4
8	160	100	50	1.0	×	×	20	1.6
9	150	140	60	1.5	×	×	10	1.6
10	130	160	60	1.2	×	×	20	1.4
11	90	140	70	1.1	×	20	10	1.5
12	80	160	70	1.2	30	×	10	1.7
13	90	130	90	1.0	20	20	10	1.5
14	80	120	70	1.1	×	20	20	1.5
15	70	90	80	1.1	×	×	10	1.5
16	60	100	80	1.1	×	×	10	1.6
17	70	90	70	1.1	×	×	10	1.7
18	50	150	90	1.2	×	×	10	1.5

× Undetected.
* Based on 846 μμc/gm.

stance, a small portion of the total milk supply over a short space of time such as in the case of the Windscale Incident as opposed to very widespread contamination over a longer period of time.

3. Other possible control methods may be used. The simple expedient of keeping cattle in the barn during periods of fresh fallout and feeding them forage and other foods harvested earlier can have a marked effect on the levels of short-lived radionuclides found in milk. Data obtained during such a study (see Table 7) show that iodine-131, barium-140, and cesium-137 in fresh fallout were almost entirely absent in milk obtained from cattle remaining in the barn and fed previously harvested foodstuffs in contrast to milk obtained from pasture-fed cattle.[6] Another method of control might be the removal of the radioactive material from the particular dietary item without affecting its quality. Research is going on, for example, as to the feasibility of the removal of strontium-90 from milk on a relatively large scale. Laboratory studies show that iodine-131 may also be removed.

4. The half-life of the radioactive material must be considered. In some instances, as in the case of the short-lived isotopes, a temporary holding period might be feasible. Here again, depending upon the length of time, availability of stockpiles of uncontaminated food as well as facilities for holding could be important.

5. Other internal or external sources of radiation exposure to the same organ must be evaluated.

6. Relative contribution of other dietary items to the total daily intake of the nuclide must be noted.

7. Physical, chemical, and other factors have an effect on the relationship between intake and uptake of the nuclide. The use of stable iodine has been considered as an addition to the diet to reduce uptake of radio-iodine. Attention must be directed not only to the effectiveness and feasibility of such a measure but also to its possible hazards.

8. Consideration must be given to the time and effort required to effect corrective action.

Conclusion

From the preceding discussion it is evident that in this field it is far easier to raise questions than it is to answer them. The deeper one goes into the problems of establishing permissible levels in environmental media and of applying them in normal and emergency situations, the more difficult it is to emerge with clear, direct, and generally applicable standards. Particularly in the case of emergency situations, it would appear that it is virtually impossible to pre-judge these situations. General guidelines, of course, must be provided. However, there appears to be no substitute for the careful evaluation of all relevant facts about the situation by competent, responsible, authorities at the time.

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External Gamma Activity

Division of Radiological Health, Public Health Service

Daily measurements of external gamma radiation are made at stations of the Radiation Surveillance Network to assure detection of any substantial deviations from normal background levels. Portable geiger-mueller survey instruments are used to obtain measurements at three feet above the ground surface. February 1962 data reported in table 1 are characteristic of individual station observations which in recent years have defined the range of normal background values.

TABLE 1.—EXTERNAL GAMMA ACTIVITY, FEBRUARY 1962

Station location		Average (mr/hr)	Station location		Average (mr/hr)
City	State		City	State	
Adak	Alaska	0.01	Lansing	Mich	0.02
Anchorage	Alaska	0.01	Minneapolis	Minn	0.01
Attu	Alaska	0.01	Jackson	Miss	0.01
Cold Bay	Alaska	0.01	Pascagoula	Miss	—
Fairbanks	Alaska	0.01	Jefferson City	Mo	0.01
Juneau	Alaska	0.02	Helena	Mont	0.03
Kodiak	Alaska	0.02	Lincoln	Nebr	—
Nome	Alaska	[a]—	Trenton	N. J	0.02
Point Barrow	Alaska	0.01	Santa Fe	N. Mex	0.03
St. Paul Island	Alaska	—	Albany	N. Y	0.03
Phoenix	Ariz	0.02	New York	N. Y	—
Little Rock	Ark	0.01	Gastonia	N. C	0.02
Berkeley	Calif	0.01	Bismarck	N. Dak	0.01
Los Angeles	Calif	—	Columbus	Ohio	0.01
Denver	Colo	0.02	Oklahoma City	Okla	0.02
Hartford	Conn	0.01	Ponca City	Okla	0.04
Washington	D. C	0.02	Portland	Oreg	0.02
Jacksonville	Fla	0.01	Harrisburg	Pa	0.01
Miami	Fla	0.01	San Juan	P. R	—
Atlanta	Ga	0.02	Providence	R. I	0.02
Agana	Guam	0.03	Columbia	S. C	0.02
Honolulu	Hawaii	0.02	Pierre	S. Dak	0.02
Boise	Idaho	0.02	Nashville	Tenn	0.01
Springfield	Ill	0.01	Austin	Tex	0.01
Indianapolis	Ind	0.01	El Paso	Tex	0.02
Iowa City	Iowa	0.01	Salt Lake City	Utah	0.02
Topeka	Kans	0.02	Richmond	Va	0.01
Frankfort	Ky	0.01	Seattle	Wash	0.02
New Orleans	La	0.02	Madison	Wis	0.02
Augusta	Maine	0.02	Cheyenne	Wyo	0.02
Baltimore	Md	0.02	Sundance	Wyo	—
Lawrence	Mass	0.02			

[a] Dash indicates no data received.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U. S. Atomic Energy Commission receives from its contractors quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Various summaries of the environmental radioactivity data for 18 AEC installations have appeared in *RHD* since November 1960. Summaries follow for Argonne National Laboratory and Rocky Flats Plant, covering the third and fourth quarters of 1961.

The measured concentration of a radioactive substance in air and water may be compared with the Maximum Permissible Concentration (MPC) of that substance as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in National Bureau of Standards "Handbook 69".

For purposes of clarity and perspective, a few of the applicable environmental MPC values are listed in table 1. Such values are intended as guides only. For further clarification, "Handbook 69" should be consulted.

The establishment of MPC's does not imply that each nuclide may be permitted to be present at 100% of its MPC concentration. If the concentration of each nuclide is expressed in terms of percent of its MPC, the sum of all the percent values should not exceed 100%.

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of radionuclides	Environmental MPC's	
		Water ($\mu\mu$c/liter)	Air ($\mu\mu$c/m^3)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, Ra^{223}, Ra^{226}, Ra^{228}, Pa^{231}, and Th-nat are not present[1]	2,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present [1]	600	—
3	If Ra^{226}, Ra^{228} are not present [1]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present [1]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, and Pu^{241} are not present [1]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, and Bk^{249} are not present [1]	—	100
8	Barium–lanthanum-140	20,000	4,000
9	Cerium-141	90,000	5,000
10	Cerium-144	10,000	300
11	Cesium-137	20,000	500
12	Cobalt-58	90,000	2,000
13	Cobalt-60	50,000	300
14	Iodine-131	2,000	300
15	Plutonium-239	5,000	0.06
16	Ruthenium–rhodium-106	10,000	200
17	Strontium-89	10,000	1,000
18	Strontium-90	100	10
19	Uranium, natural	20,000	2
20	Zirconium–niobium-95	60,000	1,000

[1] "Not present" implies the concentration of the nuclide is small compared with its appropriate MPC. According to recent AEC Regulations (*Federal Register*, Title 10, Part 20, pages 7142–7143, August 9, 1961) a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than 1/10 and if the sum of these ratios for the group in question is equal to or less than 1/4.

In the following reports, the use of nonspecific terms as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low a laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References to table 1 will be made to designate the appropriate MPC's reported by the laboratory.

Argonne National Laboratory

University of Chicago, Lemont, Illinois
Third and fourth quarters 1961

Air Monitoring

Weekly continuous air filter samples were collected at seven locations on the Argonne National Laboratory (ANL) site as shown in figure 1 and at four off site locations at Aurora (west of ANL site), Hinsdale (northeast), Joliet (southwest), and Tinley Park (southwest). The monthly averages of alpha, beta, and several nuclide concentrations are given in table 2. The data show little differences between off-site and on-site measurements for alpha activity and most of the nuclides, inferring than ANL does not contribute detectable quantities of these activities to the atmosphere.

Analysis by gamma measurements of the long-lived fission products cerium-144, ruthenium-rhodium-106, and cesium-137, was not practical in the presence of the much higher concentrations of shorter lived fission products from the 1961 U.S.S.R. nuclear tests. Therefore, beginning with September, the shorter lived fission products cerium-141, zirconium-niobium-95, and barium-lanthanum-140 were monitored by the same method. Iodine-131 was detected but not quantitatively determined.

Water Monitoring

ANL waste water is discharged into Sawmill Creek, a stream that runs through the Argonne grounds and enters the Des Plaines River about 500 yards downstream from the waste water discharge. Sampling locations on Sawmill Creek and Des Plaines River are shown in figures 1 and 2 respectively.

On Sawmill Creek, weekly grab samples are collected upstream and three times a week downstream from the waste water outfall. The upstream flow is roughly equal to the waste water flow, yielding a dilution factor of one-half. The data in table 3 show significantly higher concentrations downstream than upstream, an indication of the radioactivity contributed to the stream by ANL. A comparison of the downstream concentrations with the environmental MPC's listed in table 1 shows that all concentrations are relatively low. The highest percent of MPC is that for Sr^{90} for the third quarter, 1.7%.

Weekly grab samples are collected from the Des Plaines River upstream and downstream from its junction with Sawmill Creek. The data in table 4 indicate that the dilution factor of the Des Plaines River is so large that the radioactivity contribution from ANL was not detected.

Grass Analysis for Iodine-131

Samples of grass were collected during August, as a followup of the program initiated in March 1961, to check the environmental deposition of idoine-131 that was released during February and March (see *RHD* December 1961). Grass has been demonstrated to be a very sensitive indicator for iodine-131. The August samples, collected near the points of release, had concentrations of iodine-131 less than the minimum level of detection, 1 μμc/gm.

Previous coverage in *Radiological Health Data*

Period	*Issue*
1959 and first quarter 1960	December 1960
Second quarter 1960	April 1961
Third and fourth quarters 1960	July 1961
First and second quarters 1961	December 1961

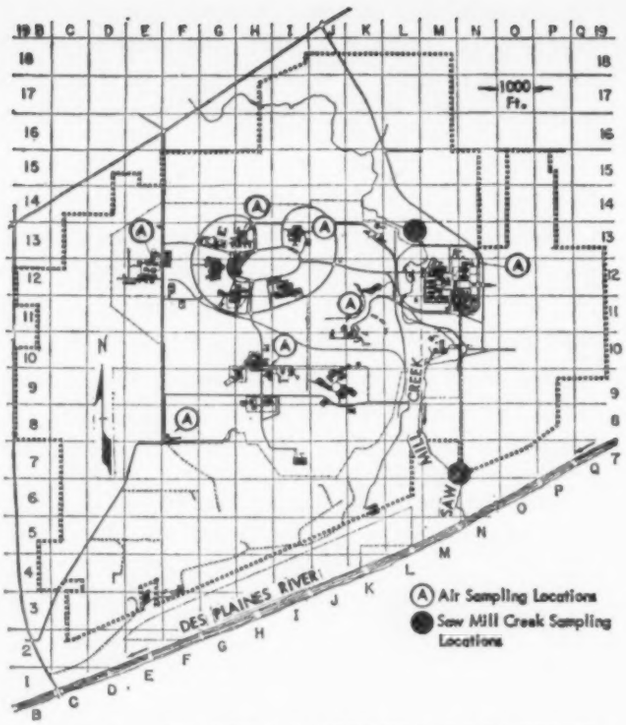

FIGURE 1.—ON-SITE SAMPLING LOCATIONS, ARGONNE NATIONAL LABORATORY

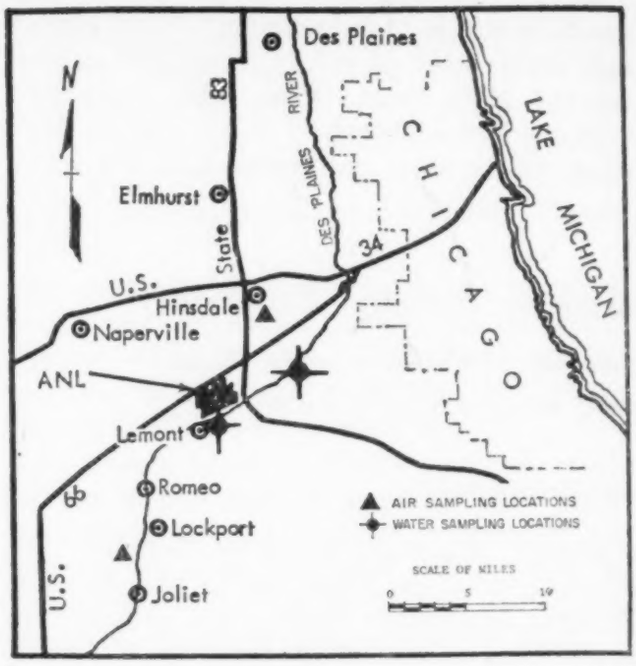

FIGURE 2.—SITE LOCATION OF ARGONNE NATIONAL LABORATORY (INCLUDING SOME OFF-SITE SAMPLING STATIONS)

TABLE 2.—ACTIVITIES IN AIR FILTER SAMPLES, ANL, 1961

[Average concentrations in $\mu\mu c/m^3$]

Type of activity	Relative sampling location	July	August	September	October	November	December
Alpha	On-site	0.0042	0.0046	0.0045	0.0036	0.0037	0.0041
	Off-site	0.0050	0.0037	0.0048	0.0033	0.0032	0.0041
Beta	On-site	0.099	0.068	12.3	7.4	7.2	5.1
	Off-site	0.112	0.064	10.6	6.6	7.3	4.4
Ce^{144}	On-site	0.011	0.007	[a] —	—	—	—
	Off-site	0.014	0.006	—	—	—	—
$Ru\text{-}Rh^{106}$	On-site	0.053	0.048	—	—	—	—
	Off-site	0.070	0.043	—	—	—	—
Cs^{137}	On-site	0.009	0.006	—	—	—	—
	Off-site	0.012	0.005	—	—	—	—
Ce^{141}	On-site	—	—	0.53	0.85	0.69	0.54
	Off-site	—	—	0.33	0.74	0.77	0.76
$Zr\text{-}Nb^{95}$	On-site	—	—	0.91	1.1	1.3	1.5
	Off-site	—	—	0.82	1.1	1.4	1.7
$Ba\text{-}La^{140}$	On-site	—	—	7.5	3.2	1.9	0.58
	Off-site	—	—	6.4	2.7	1.7	0.67

[a] Dash denotes no analysis made.

TABLE 3.—ACTIVITIES IN SAWMILL CREEK UPSTREAM AND DOWNSTREAM WATER OUTFALL, ANL, 1961

[Average concentrations in μμc/liter]

Type of activity	Sampling location	Third quarter	Fourth quarter	Calendar year
Total alpha	Upstream	1.5	1.9	1.9
	Downstream	6.2	4.4	6.8
Total beta	Upstream	7.7	20.7	10.5
	Downstream	36.5	40.4	30.4
U-Nat	Upstream	1.3	1.0	1.2
	Downstream	5.7	3.3	5.6
Pu^{239}	Upstream	<0.05	<0.05	<0.05
	Downstream	0.14	0.05	0.08
Th-Pa^{234}	Upstream	1.0	1.0	1.0
	Downstream	4.9	2.6	4.7
Sr^{90}	Upstream	1.1	0.6	0.6
	Downstream	1.7	0.6	1.3
Cs^{137}	Upstream	0.6	0.8	0.5
	Downstream	2.3	2.0	2.2
I^{131}	Upstream	[a]	2.8	<1.0
	Downstream	—	2.1	3.3
Co^{60}	Upstream	<1.0	<1.0	<1.0
	Downstream	1.0	1.6	1.2
Co^{58}	Upstream	<5	<5	<5
	Downstream	118	59	86

[a] Dash indicated not reported.

TABLE 4.—ACTIVITIES IN THE DES PLAINES RIVER UPSTREAM AND DOWNSTREAM FROM SAWMILL CREEK, ANL, 1961

[Average concentrations in μμc/liter]

Type of activity	Sampling location	Third quarter	Fourth quarter	Calendar year
Total alpha	Upstream	2.2	3.6	2.6
	Downstream	2.0	3.2	2.4
Total beta	Upstream	12.8	37.7	17.2
	Downstream	12.5	36.5	16.9
U-Nat	Upstream	1.3	1.8	1.6
	Downstream	1.6	1.7	1.6
Sr^{90}	Upstream	0.9	0.7	0.6
	Downstream	1.1	0.6	0.6

Rocky Flats Plant

Dow Chemical Company, Denver, Colorado
Third and Fourth Quarters 1961

The Rocky Flats Plant (RFP) is engaged in plutonium fuel element fabrication under contract to the Atomic Energy Commission. To assure properly controlled release of radioactive materials to the environment, water, air, and vegetation, are sampled periodically and analysed for gross alpha activity. On occasions when analyses were made, most of the activity was shown to be uranium. The most active material involved in the process is plutonium.

Because the plant is located on gravel washed out of the highly mineralized Front Range of the Rocky Mountains, heterogeneous low-level deposits of uranium, thorium and radium exist in the soil of the area and are measurable in most samples of air, water and vegetation as well. In fact, the activities of these elements and their radioactive decay products are the only radioactivity detected except following periods of testing of atomic devices.

Air Monitoring

During the third and fourth quarters, 24-hour air samples were collected at Coal Creek Canyon, Marshall, Boulder, Lafayette, Bromfield, Wagner School, Golden, Denver and Westminster. The results are tabulated in table 5. The activity is believed to consist entirely of that from air-borne uranium minerals.

Water Monitoring

Water samples were collected routinely from four reservoirs at distances ranging from 3 to 8 miles from RFP. Non-routine raw surface water samples were collected from a number of streams and lakes up to 15 miles distant.

The alpha cencentrations in the 40 reservoir samples, collected during the third and fourth quarters, varied from < 0.4 to 2.5 μμc/liter.

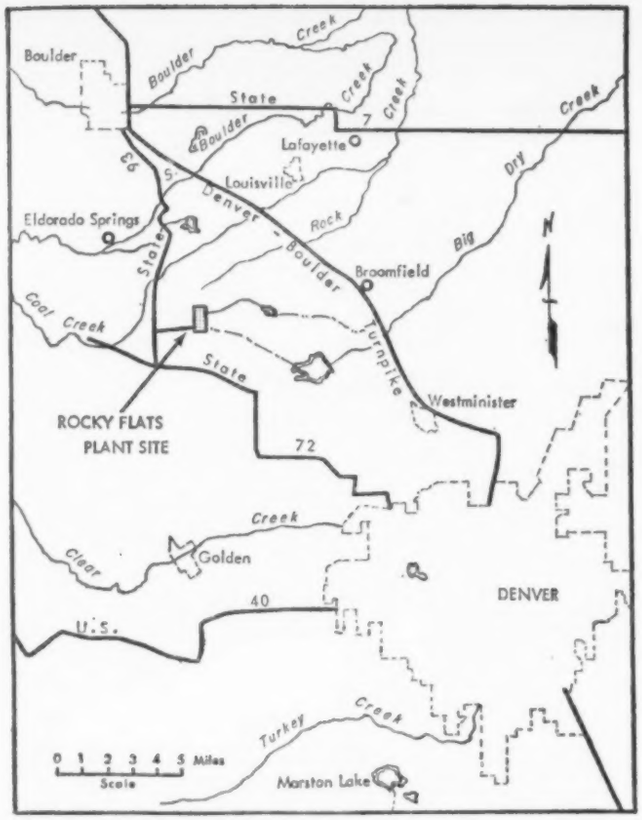

FIGURE 3.—LOCATION OF THE ROCKY FLATS PLANT ENVIRONMENT, DENVER, COLORADO

All but one of the 39 raw surface water samples had alpha concentrations below 4 μμc/liter. One sample with a concentration of 15.2 μμc/liter was analysed. All the activity was natural uranium.

TABLE 5.—LONG-LIVED ALPHA ACTIVITY IN PARTICULATES IN AIR, RFP

Month	Average alpha concentration (μμc/m³)
July	<0.020
August	<0.015
September	<0.033
October	<0.018
November	<0.011
December	<0.012

Vegetation Samples

A total of 93 vegetation samples collected during May and June 1961 were analyzed during the third and four quarters. The average alpha activity was 48 μμc/kg dry weight with a standard deviation of 30 μμc/kg.

Previous coverage in *Radiological Health Data*

Period	*Issue*
Third quarter 1960 through second quarter 1961	November 1961

Nevada Test Site

Atomic Energy Commission
March 1962

Following a subsurface nuclear detonation on March 5, 1962, at the Nevada Test Site, small amounts of radioactivity were detected off-site. The highest gamma radiation level measured at a populated area off-site was at Warm Springs, Nevada (about 70 miles from the Site), where two or three persons were present. The total radiation exposure estimated at this location was less than one milliroentgen.

Some spot readings at Clarke Station (about 65 miles from the Site, where two persons were present) showed somewhat higher values than at Warm Springs, and the total exposure might have been somewhat higher. Both of these radiation doses were too low to be recorded on a standard film badge.

The gross beta activity in the air at Warm Springs is given in the table below.

TABLE 6.—GROSS BETA DETERMINATIONS OF SURFACE AIR, NTS, MARCH 1962

(Concentrations in μμc/m³)

Time and date of collection	Time and date of counting	Activity at time of counting
0600–1010, March 5	2217, March 5	56.3*
	0842, March 6	32.3
1020–1515, March 5	2100, March 5	650
	0830, March 6	287
	1625, March 7	87
	0904, March 8	76
	1304, March 15	24
1520–0600, March 5–6	0955, March 7	15.2
	1327, March 15	12.3

* Current radioactivity levels in this area fluctuate at around 10 μμc/m³.

Reported Nuclear Detonations

Previous issues of *Radiological Health Data* since October 1961 have published available information on the dates, sizes, and types of nuclear tests conducted at various locations by the United States and the Union of Soviet Socialist Republics. The April 1962 *RHD* contains summary data through March 31, 1962. The following table reports on subsequent tests through April 30, 1962. Low yield range has been announced as meaning about a nominal (20-kiloton) yield, low-intermediate to mean a nominal and one megaton yield.

REPORTED U.S. DETONATIONS, APRIL 1962

Test number	Location	Date	Size	Type of test
27	Nevada Test Site	April 5	Low yield	Underground
28	Nevada Test Site	April 6	Low yield	Underground
29	Nevada Test Site	April 12	Low yield	Underground
30	Nevada Test Site	April 14	Low yield	Underground
31	Nevada Test Site	April 21	Low yield	Underground
32	Christmas Island, Pacific	April 25	Intermediate yield	Atmospheric
33	Christmas Island, Pacific	April 27	Intermediate yield	Atmospheric
34	Nevada Test Site	April 27	Low yield	Underground

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